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AND

PATTERN-MAKER.

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A WEST AFRICAN IRON WORKS.*

By C. V. Bellamy.

To-day there is, in the hinterland of the British colony of Lagos, West Africa, not more than three days' journey from the coast, a small village whose inhabi-

Fig. 1.—Washing the Pounded Ore.

tants have been engaged in the extraction of iron for generations past, and where the methods are the same, probably, as those practised by the earliest workers in this metal. The people follow the habits of a life which, measured by our standard, would be termed savage, yet the existence of an industry such as is herein described removes from them this stigma.

Although these smelting works are situated within one short day's march of Oyo, the capital of the Yoruba country and the seat of the Alaffin or king of that nation, it is only recently that they have been visited by a white man. Before making the expedition it was necessary, as an act of courtesy to the king, to obtain permission to do so, through the medium of the Aremo, the eldest son of the Alaffin, who stands in relation to his father much in the same position as the crown prince of a Royal house of Europe. The town of Oyo is situated at a distance of 35 miles to the northward of Ibadan, which is the upper terminus of the railway. The smelting village is about three or three and a-half days' journey from Lagos, which is reached by steamers from Liverpool, trading to the west coast of Africa, in about seventeen days or less.

On our journey evidences of charcoal-burning seemed to point to the proximity of our quest, and steps had to be taken to send ahead to warn the villagers of our approach and to explain that we desired to come in peace and to go in peace. This precaution is still necessary in many of the villages in these parts, because the natives, being frequently extremely suspicious of strangers, will sometimes abandon their houses in a body and conceal themselves for days in the bush until the disturbing element has passed on.

The community consists of about a hundred or a hundred and twenty souls, the whole of them—men, women, and children down to the ages of five or six—occupied in the smelting, etc., of iron. They have followed this avocation, as a separate tribe, apparently for generations, though not always in this same neighbourhood.

The crude ore is mined in a manner strongly suggestive of the ancient stream-workings in Devon and Cornwall, and elsewhere. In mining parlance it may be described as "placer"; the ferruginous deposit is met with at a depth of not more than from 6 to 8 ft. below the surface of the ground, and occurs in a shale. This shale is excavated, with the aid of a rude pick, in pieces weighing from 3 to 5 lbs., and is carried to the smelting works for treatment. This consists, firstly, in roasting it over night over a fire of green timber. The quantity of ore on each fire hardly exceeds a barrowful. The next

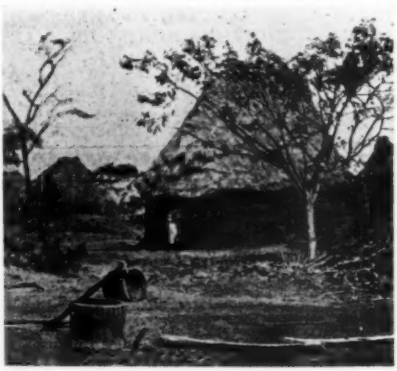


Fig. 2.—Ladle and Mortar.

morning the ore is pulverised in an ordinary wooden mortar. The poundings are screened until there is nothing remaining in the mortar, the sieve consisting of a native made basket, rather openly woven, and they are then borne away to the river-side for the purpose of washing

* Abstract of paper read before the Iron and Steel Institute.

or panning. This is carried out by women in the following manner : A hole is dug in the ground about 2 ft. deep, and about 2½ ft. in diameter, and is filled with water to within about a foot of the top. Into this one of the women descends, provided with a calabash tray about 18 in. in diameter, into which she pours a quantity of ore poundings. She proceeds to wash this by means of a circular oscillating motion, by means of which the lighter, finer, and probably largely organic, matter is discarded, and falls to the bottom of the pit, while the heavier particles remain in the tray. When this has undergone washing sufficiently in the pit, it is set aside for a further washing by a second woman seated on the ground near by. This second treatment consists in placing it in

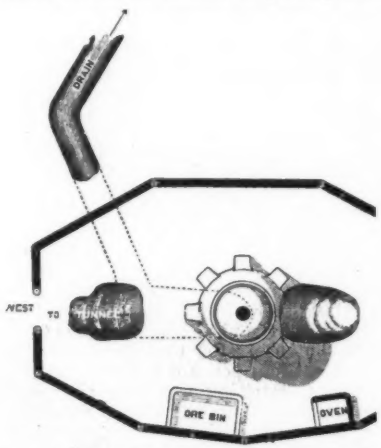


FIG. 3.—PLAN SHOWING ARRANGEMENT OF SHED.

another tray and sluicing it in clear water. The ore is then deemed ready for the cupola, and the residue of finer material is thrown away. The washed ore is conveyed to the smelting house and poured into the kiln, as occasion may require, in a damp state.

There are in the village altogether eleven smelting houses, and as each is an exact reproduction of the other, it will only be necessary to describe one. Each shed measures from 25 to 26 ft. in length, by about 16 ft. in width, a doorway being provided at each end. The walls are built of clay-daub, and vary in height from 4 to 6 ft. From the ground level to the ridge of the roof the height is about 5 ft., so that, although the roof is covered with a thatching of palm leaves, there is little chance of its becoming ignited by the flames from the cupola. These smelting houses are, in nearly every case, placed east and west along the longer axis.

The principal feature of the interior is the cupola, which stands about the centre of the shed. It is built entirely of clay, and occupies a circular space, whose diameter is from 7 to 7½ ft.; the height of the cupola from floor level to the crown of the dome is about 3 ft. 9 in. On the eastern side and facing one of the doorways is the entrance to the cupola, the sill of which is about a foot below the floor, and an irregularly-shaped depression in the floor, about 4 ft. long and 3 ft. 4 in. wide, is provided to give access to the doorway, and therefore to the interior of the cupola. This doorway occupies about a fourth part of the circumference of the cupola, and around the remaining three-fourths there are seven rough counterforts, each measuring about or rather less than a foot every way, alternating with six openings through the walls of the cupola. The sides, top and bottom of each opening slope inwards and downwards towards a point about the centre of the base of the furnace.

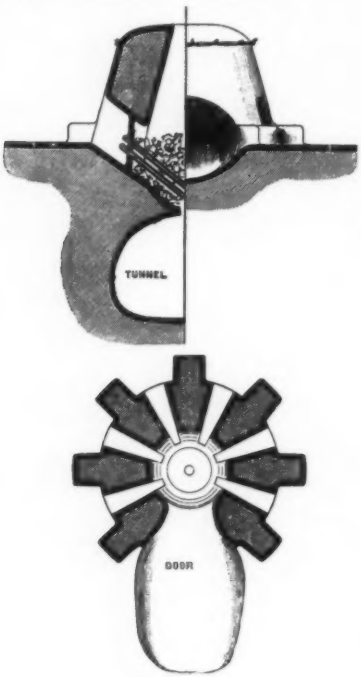
The dome of the cupola is rounded up on the outside slightly, and measures about 3 ft. 6 in. across, and a circular orifice or flue is left in the centre of the dome about 9 in. in diameter. A short distance below the curve of the dome a rope of twisted vines or creepers is passed round the cone and pegged down into the clay for the purpose of binding the walls securely together.

The interior of the cupola measures in its greatest diameter about 2 ft. 6 in. at a height which corresponds to the floor level outside, and the bottom of the furnace, which is rounded, is about 2 ft. below this point. The height of the furnace is about 5 ft., and the space is of an elongated egg-shape in section. The larger rounded end is, of course, at the bottom, and the sides taper inwards on easy curves towards the flue in the crown of the cupola.

In the centre of the bottom of the cupola is an aperture about 3 or 4 in. in diameter, which communicates with a short tunnel below the floor of the shed, to which access is had by means of a pit immediately inside the western entrance to the shed. On the northern side of this tunnel a branch is provided, passing out underneath the walls of the shed, which is provided for the purpose of carrying off any moisture which might accumulate in the tunnel during the rainy season.

There are two other permanent features of the interior of the shed, one consisting in a small vertical oven about 2 ft. 6 in.

long and 1 ft. 10 in. wide by 4 ft. in height. This is employed for firing the earthenware pipes, each about 2 ft. long and 1½ in. internal diameter, through which the draught is led into the cupola. The other fixture is merely an ore bin about 4 ft. 8 in. long and 2 ft. 8 in. wide, the walls of which are about 9 in. high. In both cases these fittings are constructed of clay-daub. Around the rest of the shed the wall-space is occupied with stacks of charcoal, calabashes of flux and metal, tools, pestles and mortars, and a miscellaneous assortment of articles.



PLAN.

FIG. 4.—DETAILS OF CUPOLA.

The process of smelting occupies a period of about thirty-six hours. The first operation consists in closing the six vertical apertures by setting in each two earthenware pipes, one above the other, built around with charcoal, inclining downwards towards the centre of the bottom of the furnace where all the pipes concentrate; the opening is then sealed with clay, but the entrance to the furnace is not closed until the last moment. The actual charging of the cupola commences, firstly by closing the orifice in the bottom of the furnace which communicates with the tunnel, this being done with the aid of a cone of damp sand. Live charcoal is then placed in the centre of the cupola and the firing started; as soon as the fire is properly established, proceedings are taken for the closing of the door of the cupola. In this instance there are fixed three pairs of earthenware pipes in positions corresponding with those fixed in the six vertical apertures around the cupola. They are, as in the other cases, packed around with charcoal and finally built around with a clay seal.

The result of closing up the openings and of confining the inward flow of air to the pipes is immediately apparent by a brightening of the flame and a more brisk heat. It will be seen that there are altogether nine pairs of pipes supplying the necessary draught to the fire. The average diameter of each pipe is about 1.40 in. This gives a sectional area of, say, 1.54 in. As the opening in the crown of the cupola is 9 in. in diameter, a simple calculation shows that the outlet is two and a-third times as great as the inlet; by this means forced draught is obtained in a very simple but effectual manner.

As soon as the fire in the cupola is well established, a flux is thrown on to the fire through the flue in the crown of the cupola. This flux is obtained from the slag or refuse clinker from each successive smelting. How it was first obtained the headman of the village was not able to explain, but he stated that it increased as time went on, because the yield of flux from each smelting was more than sufficient for any one subsequent operation. He acknowledged that, without the aid of the flux, they would not be able to carry on their work, and that if, by any misfortune, they became deprived of all their flux, their industry would cease.

A cupola commences to be charged at daylight, about 5.30 a.m., and about two hours afterwards, when the fire is well alight, a quantity of flux, about 5 lbs. in weight, and about 2 bushels of charcoal, are thrown on to the fire. After a further lapse of about two hours, or, say, about 9.30 a.m., this flux is drawn off through the aperture in the bottom of the hearth communicating with the tunnel, and a similar quantity of flux as before, together with a similar quantity of charcoal, are added. This makes two charges of flux before any smelting is commenced. Again, about two hours later, or, say, 11.30 a.m., this flux, the second charge, is drawn off, after which the fire is considered to have undergone sufficient cleaning, and the real operation of smelting commences.

Firstly, about 5 lbs. of flux are applied, then about 2 bushels of charcoal, the quantities being the same as in the former charges, but immediately afterwards a quantity of iron ore of the same weight as that of the flux, say, 5 lbs., in the washed state, and still moist, is thrown into the cupola.

This operation of feeding the cupola with ore is repeated ten times from start to finish, but prior to each charge the flux is drawn off in the manner already described, and only upon the ninth and tenth, the final charging, and also immediately before the cupola is emptied, is the flux reckoned of any value for assisting in subsequent smeltings. These are, therefore, the residue of the eighth, ninth, and tenth charges. There are, therefore, three occasions during each firing when flux may be collected, and it may well be understood that the supply exceeds requirements.

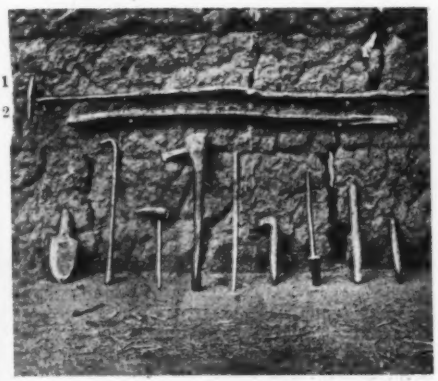


FIG. 5.—TOOLS, &C., USED BY THE SMELTERS.

1. Wooden scraper for raking out the fire. 2. Wooden crossbar with iron shoe. 3. Wooden trowel for handling hot clinker and flux. 4. Iron hook for hooking out the slag. 5. Iron pricker for opening hole in bottom of furnace: wooden handle. 6. Axe for chopping wood. 7. An English two-foot rule to give scale. 8. Hammer for breaking up pig-iron. 9. Iron pricker with wooden handle, used in the same way as No. 5. 10, 11. Wooden bars for opening and closing the air inlet pipes. The iron of which these tools are made is produced locally.

The quantity of ore put in at each charge gradually increases—using the words of the head smelter—from about 5 lbs. to 30 lbs. of ore, which maximum is reached upon the eighth charge, the last three being equal. The precise moment when the fire is ready for the reception of each successive lot of ore is a matter entirely of judgment and experience, but the interval is usually from two to three hours, a period of five hours being allowed to elapse between the last or tenth charge and the opening of the cupola.

At the appointed time, and as soon as the cupola gives indications of being ready to be opened, one of the attendants descends into the tunnel communicating with the bottom of the cupola, and, with the aid of an iron pricker, opens out the orifice in the bottom, thus allowing the flux to run off.

Then preparations are made to open the cupola, and, with the aid of a wooden crow-bar shod with iron, the clay seals over the six apertures are broken up, the earthenware pipes removed and thrown to spoil, and finally the doorway of the furnace is opened. The contents of live charcoal are raked out through the doorway with the aid of a wooden scraper; they are then drenched with water, and carried away. Then the smelted metal is revealed lying in the bottom of the furnace in a solid cake or pig. After a good deal of manœuvring, and when nearly all the charcoal has been withdrawn, a loop of green creeper from the forest is thrust in and hooked over the cake of metal, and by this means the latter is drawn forth out of the cupola, and eventually out of the shed, in a red-hot state, and is allowed to cool off until the following morning.

The quantity of ore employed from first to last in charging each cupola would appear to be about 162 lbs.

The weight of each pig of smelted metal as the yield of each operation would be, as near as one could judge, between 70 and 80 lbs. That is to say, that for every 100 lbs. of ore thrown into the cupola 46 lbs. of metal are produced. The remaining 54 per cent. of ore comes away in clinker from which the necessary flux for subsequent smeltings is selected, and the residue thrown to spoil.

Probably the most remarkable feature in the whole of the process is this use of selected clinker for a flux. This may throw light upon what is now frequently a matter of doubt—namely, the medium employed by the ancients in their smelting operations.

The head smelter, in the course of many conversations on the subject, showed himself to be extremely intelligent. Amongst other things he said that to the best of his knowledge there were no smelting works in this part of West Africa. He said that they supplied all the markets in the neighbourhood.

The pig-iron, after it has cooled down

sufficiently, is broken up into convenient lumps for the purposes of sale or barter, and beyond this undergoes no change whatever from the time it leaves the cupola to the time it reaches the smith's shop, where the puddling is done. In order to witness this part of the work a visit was paid to a smithy in the town of Oyo on our return thither, and here again everything was of the most primitive character.

The bellows consisted of a pair of circular wooden bowls about a foot in diameter, connected by an air passage constructed of the same, from which two wooden pipes, to do duty for the tue-iron, lead to the hearth; over the top of each bowl is loosely secured an undressed goat-skin, to which is fastened in the centre of the bowl a long bamboo rod, one of which is held in each hand. The skin is

FIG. 6.—GROUP OF SMELTERS.

very slack, and by raising the lowering rods alternately a more or less continuous current of air is supplied to the hearth. There is no inlet valve to these bellows, and the air supply enters by the wooden tue-pipes, a space being left between the hearth stone and the nozzles for the purpose; the bellows and hearth rest upon the ground.

The other fittings of the smithy were of a similarly primitive character. For heavier work a large smooth, undressed and water-worn stone does duty for an anvil, but for smaller work another anvil is provided like a silversmith's, made of metal produced locally. The hammers look at first sight like so many rude lumps of iron roughly handled with the same, but a closer inspection shows them to be systematically shaped and diamond-wise in section so as to expose a flat or a straight plane by a single turn of the wrist; the pattern is ingenious. With such simple means as these the smith puddles the iron which is smelted after the manner already explained.

Getting into conversation with the smith, he explained that all the metal he used came from the smelting works which we had just visited, at Olaigbi; there was no regular price paid for it as there is no standard of weights and measures in the country, but it is exposed for sale in little heaps: this for threepence, that for sixpence, and so on. He could not give any idea of the market value of the metal, but of this some notion had been gained at the smelting works where, as we stood to witness the pig being drawn out of the kiln, we were told that the yield was good, and would fetch about ten shillings. We judged that the weight was about 60 lbs., at which rate the price would work out at 2d. per lb., or £18 13s. 4d. per ton, or perhaps six times the price of pig-iron on the English market.

Among the miscellaneous articles in this native smithy there happened to be an English rose-head nail, and for curiosity's sake we asked the smith what he thought of such metal. His reply was of the most emphatic character, "It is no good!"

In the case of another smithy which we visited in a village to the southward, we found the same lumps of native iron from the same works, but here it seemed that foreign influence was beginning to be felt, and a brisk trade was being carried on in reaping and pruning hooks, knives, etc., made out of hoop iron of the ordinary type imported from Europe. But the smith acknowledged with great frankness that they were only made to sell, and with many a shake of the head said that they did not last, as the metal was not to be compared with that of native manufacture.

Not the least important feature in this industry is the marked regularity which characterised each operation and the enthusiasm which seemed to inspire the workers. It is strangely at variance with the usual custom of the Ethiopian. All indicated systematic control and the strong hand of authority and method only acquired by long practice, and passed on from one generation to the next. Each cupola is run on the share system under a separate section of the village.

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WORLD'S LEAD PRODUCTION.—Messrs. Julius Matton report the world's production of lead in 1903 was 910,000 tons, as against 903,000 tons in 1902.

AN IMPROVED TEST BAR.*

By J. F. Brown.

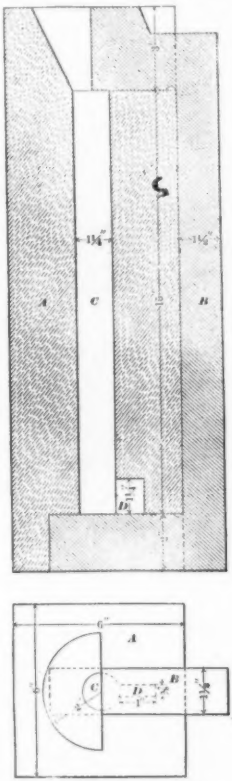
In the early part of this year a committee was formed by the American Society for Testing Materials for the purpose of deciding upon a set of specifications for cast iron. This committee proposed for adoption what they called the "arbitration bar," which is a bar 15 in. long and $1\frac{1}{4}$ in. diameter, cast on end in dry sand. The universal adoption of this bar will go far towards placing the whole question of testing cast iron upon a fixed basis.

Before we adopted the "arbitration bar" we used to take four separate tests from each air furnace heat, one each for chill, chemical analysis, tensile test and shrinkage, paying no regard to transverse strength and deflection. Now with the "arbitration bar" we could get transverse, tensile, and chemical tests, but not shrinkage and chill, and to get these very important points of information I introduced what I venture to call an improvement on the "arbitration bar." We have used this new bar with great success for about six months.

Taking it for granted that a bar 15 in. long and $1\frac{1}{4}$ in. diameter was all that could be desired with regard to length and section, we adopted these dimensions, then made a core A and cast iron yoke B, placed as shown in the sketch, and pouring it from the top we produce the bar C, which has a small projection D.

After cleaning the bar we knock off the projection and measure the depth of chill, then place it between the yoke in the same position as it was when cast, keeping it close to the top end, and measure shrinkage with a tapered scale graduated to $\frac{1}{128}$ in. You will note that the bar being 15 in. long is one-fifth of the total length longer than 1 ft. To get the shrinkage per foot we deduct one-fifth from the shrinkage shown on the scale. This I found from actual measurements to be .02 higher than what appears in the casting, so that we consider .12 shrinkage to be .10 in the casting, and, therefore, normal for general work. After measuring shrinkage the bar is broken on a testing machine, giving transverse strength and deflection; then one-half is turned and threaded according to standard specifications and tested for tensile strength. The other half is clamped on end in a jig and drilled in the clean broken section for the chemical analysis. Thus you see from the one bar we get shrinkage, chill, transverse strain, deflection, tensile strength and chemical analysis.

Samples of broken bars show a fine, clean, even fracture—a result attributed to the dry sand core. There are no signs of shot in the bars caused by metal falling on to the iron yoke. The only trouble has been by pouring them when the iron would hardly come out of the ladle. Then there would be small holes in the bar. It is really surprising how cold the iron



Improved Test Bar.

can be and yet produce a solid bar. We rub a little dry plumbago on the yoke where the metal strikes it, just enough to give a polish. The core, being made with a piece of $\frac{1}{4}$-in. cold rolled steel bar just twisted out and not rapped at all, is perfect as to size and no blacking is used to make it skin well, because that would alter the size. The cost of these cores is small; a boy can run six an hour very easily.

* Read at a monthly meeting of the Pittsburg Foundrymen's Association.

THE BREAKAGE AND RENEWAL OF A LARGE CYLINDER.*

By Mr. Hector MacColl.

Some time ago a fast passenger steamer returned to port with damaged machinery. She had a single screw turned by three-crank compound engines, the h.p. cylinder, working with steam of 95 lbs. pressure, being in the middle, exhausting into a low-pressure cylinder forward and into another aft. On the morning of the second day of the voyage loud pounding was heard in the h.p. cylinder, the engines were stopped, and it was found that the cylinder was damagel beyond repair.

As soon as possible after the vessel's return, a contract was entered into for the renewal of the h.p. piston rod, piston and cylinder, with other work in connection therewith, the price being about £1,600, and the work guaranteed to be completed in eight weeks under a heavy penalty, with corresponding premium for earlier completion. It was arranged that the new piston should be finished one inch smaller in diameter than before, but the cylinder liner to be made of the original external diameter, and thus finished half an inch thicker, so as to admit of reboring to the original size, should that ever be required. The broken cylinder with double piston-valve casings had been cast in one, but, as the relative positions of the various parts permitted, it was considered better to cast the new cylinder and casings separately, bolting them together as shown in Figs. 1, 2 and 3.

On the second day the cylinder was disconnected and removed from the ship. On the third day the cylinder liner, weighing 5.05 tons, was cast. On the thirteenth day the cylinder, weighing 8.6 tons, was cast. On the eighteenth day the valve casing, weighing 8.5 tons, was cast. On the morning of the forty-seventh day the whole work was sent out of the shop complete. During the day the new cylinder was lifted into its place, and all the joints carefully tested and found to fit accurately. It was then lifted out for the application of jointing material, and, finally, bolted in place that day. On the fifty-sixth day from date of contract all the work was completed. The total weight of castings amounted to 25.5 tons, and the detail of these weights, as well as the dates just given, are more clearly seen in tabular form:—

Current Days from Date of Order	2—Cylinder out of ship.		
	3—Liner cast,	Weight	5.05 tons
	13—Cylinder cast,	,,	8.6 ,,
	18—Casings cast,	,,	8.5 ,,
	Other castings,	,,	3.35 ,,
	Total	..	25.50
	47—Work sent out of shop.		
	56—Work completed.		

As it may appear strange that the contract was finished exactly to time, it should be explained that as soon as it was evident that the work could be completed inside of that itme, a strong hint was given that payment of a premium was to be, as the Board of Trade instructions say, "discouraged." It was then evident that, to parody a well-known newspaper phrase, a premium had been embodied in the contract, "not necessarily for payment, nor as a guarantee of good faith," but solely to legalise the penalty. So overtime was eased off, and the work finished comfortably at the contract date. One of the obvious lessons learned from the occurrence is to arrange the relative positions of counter bore and piston packing rings, so that the latter do not overrun the former at either end of the stroke. This was done by making the new h.p. piston as shown in Fig. 6; while the two l.p. pistons were altered, as shown in Fig. 5, to effect the same purpose. But, as the practice is now general, nothing more need be said on the subject.

A more important lesson, both to engineers and to shipowners, is the advantage of subdividing large cylinder castings. It has been too long the custom in this district to look upon the cylinder as a thing of which one cannot have too much in a single casting. Large and complicated cylinders have not only valve cases cast on, but sometimes small fittings, causing the ironfounder to run unnecessary risks, and involving the engine builder in extra expense machining small parts on large and costly machines, with consequent delay in completing the various operations. Probably one reason for this practice is that on the upper reaches of the river the foundry is almost entirely dissociated, both financially and geographically, from the engine works. The engineer too often looks upon the foundry as a dirty, smoky place, to be avoided as much as possible, whereas it is a department of his business in which an intelligent interest will be well repaid. The ironfounders with some pride in his art will do his best to cast structures of which his experience disapproves, but it would be to the advantage of both if his brother, the engineer, regularly conferred with

* Extract of paper read before the Institute of Engineers and Shipbuilders in Scotland.

him. In the present instance the renewal might have been done in half the time had the cylinder body, bottom, and valve casing been cast separately, and, while

Fig. 1

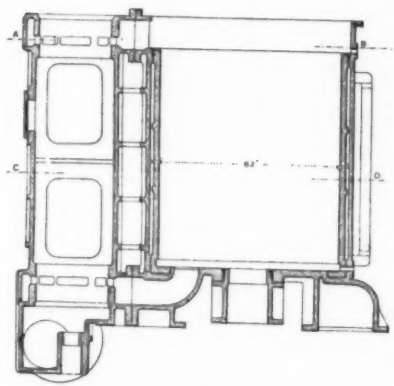
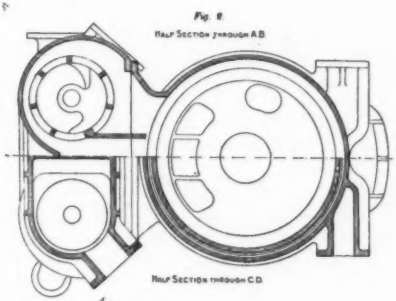


Fig. 2

HALF SECTION THROUGH A.B



HALF SECTION THROUGH C.D.

Fig. 3.

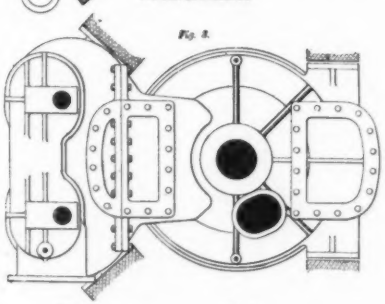


Fig. 4.

ORIGINAL AS ALTERED

Fig. 5.

AS ORIGINAL AS ALTERED

four weeks would have been of enormous value to the owners, the suggested method of construction need not have increased the original cost.

BLOWERS FOR CUPOLAS.

From an interesting pamphlet entitled "Steel Pressure Blowers," issued by the Buffalo Forge Company, of 39, Victoria Street, S.W., we extract the following relative to blowers for cupola service :—

A proper air supply to the cupola is the chief consideration leading to economical, rapid, and continuous melting, and also to the fine quality of iron obtained. It further results in the most economical fuel ratio. The steady trend of foundry cupola practice has been to decrease the blast pressure and increase the tuyere area, so as to supply the necessary air volume at as low pressure as is practicable. This has been found to give the best results with the least power consumption. Owing to the decreased density of air in warm weather, it becomes necessary to supply a greater volume of air than is required in cold weather to melt the same quantity of iron. At such times, the flexibility of an independent engine or motor for driving the blower will be appreciated.

In order to reduce frictional losses, all blast piping should be of ample diameter, free from sharp bends, and as short as possible. Blast gates should be included in every installation.

These blowers may be built as up-blast, down-blast, top-horizontal or bottom-horizontal discharge fans. The hand of a fan or blower is determined by the side on which the pulley is situated. Standing facing, or nearest to the discharge outlet. a fan is right or left hand according to whether the pulley is on the right or left hand side. The following is a table of speeds and capacities for cupola service :

Number of blower.	Inside diameter of cupola.	Pressure in ounces.	Revolutions per minute.	Melting capacity in lbs. per hr.	Cubic ft. of air required per minute.
4	20	8	4,732	1,545	666
5	25	8	4,209	2,321	773
6	30	8	3,660	3,093	951
7	35	8	3,244	4,218	1,486
8	40	8	2,948	5,425	2,199
9	45	10	2,785	7,818	3,203
10	55	10	2,195	11,295	4,934
11	65	12	1,932	16,955	7,707
11½	72	12	1,647	22,607	10,276
12	84	12	1,625	25,836	11,744
4	20	9	5,030	1,617	717
5	25	10	4,726	2,600	867
6	30	10	4,108	3,671	1,067
7	35	10	3,612	4,777	1,668
8	40	10	3,310	6,082	2,469
9	45	12	3,260	8,598	3,523
10	55	12	2,413	12,378	5,431
11	65	14	2,116	18,357	8,358
11½	72	14	1,797	25,176	11,144
12	84	14	1,775	28,019	12,730

A NEW FOUNDRY OF AMERICAN DESIGN.

It is often the case that the designer gives almost his entire attention to the plant within doors, to the neglect of the exterior and the building itself. It is worthy of remark that in the new foundry recently erected by the Hilles & Jones Company at Wilmington, Del., this has not been the case. This building has a large part of its exterior of glass, affording unusually good lighting to the shop within. Ventilation has been given equally thoughtful consideration. The principal points of interest in the new building, aside from its novel method of construction, are the outdoor facilities for the handling of raw material and product, and the modern interior equipment. The pre-existing buildings include a pattern shop and storage, an erecting shop, machine shop, various sheds and storehouses.

The Foundry Building.

The building occupies a site 210 by 250 ft., and is new with the exception of a wing along one side and a low brick building at the rear, which have been made parts of the complete structure. The walls of the new part are of concrete to a height of 14 ft., and are of glass set in iron framework the remainder of the distance to the roof. A monitor, 20 ft. wide and 7 ft. high at the centre, having glass sides and top, extends the length of the building along the ridge. The windows in the monitor and the alternate lights in the lowest row along the side walls are hinged at their centres, and may be opened or closed by chains. Hammered glass ¼ in. thick is used in the walls and monitor. It is interesting to add that the total glass area is some 19,000 square feet. The roof consists of blocks of reinforced cinder concrete, laid in an iron supporting frame, pointed with cement and covered with magnesia roofing material, which is both fire and water proof.

The heating and ventilating plant is a hot air plenum system, consisting of a steam driven fan blowing air, which has been heated by contact with steam coils, through galvanised iron distributing pipes to the various parts of the building. The air will ordinarily be taken from the outside, but in extreme weather the larger part will be taken from the inside of the building. This will ensure a comfortable shop for the workman, with abundance of fresh air at all times, as the cubical contents per occupant is very large.

Interior Arrangement.

The charging floor extends from the rear of the building to a point within 80 ft. of the front, and is itself 180 ft. long, 10 ft. of it projecting from the building, forming a platform to receive material from an outdoor travelling crane. The charging platform is about 40 ft. wide, and is approximately in the centre of the combined floor of the old and new parts. It is 19 ft. above the floor. An elevated trestle leads from the railway tracks into the building alongside of the charging platform. The rails are at a height of 15 ft. from the floor, bringing the floor level of the wagons to the level of the charging platform. On this trestle coke and iron are brought to the charging floor and large castings are removed from the foundry. A jib crane on the charging floor, having an air hoist, is used for handling coke and iron from wagons on the trestle to the charging platform.

Large Castings Department.

The large castings department is served by two four-motor cranes of 75-ft. span, which also cover the elevated trestle. One has a capacity of 40 tons and the other 20 tons, and each has a 5-ton auxiliary hoist. These cranes are used for the handling of large patterns, ladles and castings about the foundry, and also, as just indicated, for loading finished work. When a casting requires machine work other than can be performed by pneumatic or hand tools it is taken on a low platform car along a short track leading from the centre of the side of the foundry over and through the erecting shop. Finished castings are shipped directly from the erecting shop, as a spur from the main line of the railway connects with its track system. The cupolas, two in number, are placed at about the centre of the length of the building and rise through the charging floor at one side. The doors for charging the cupolas open directly upon the charging floor. The floor itself is of plate iron and on it are laid narrow gauge tracks for the handling of material over its area. At a point near the cupolas a platform scale is inserted in the line of the track for weighing the proportions of the charges. A plan of the tracking on the charging floor is given in Fig. 1, being marked A. The track marked B is on the main floor of the foundry. The narrow gauge tracking and equipment, including 10 or 12 cars of box and flat type, were furnished by Messrs. Arthur Koppel. The capacity of the foundry is 15,000,000 lbs. per year, and single castings can be made weighing as much as

150,000 lbs. The first heat was run on June 20 last.

The space under the charging floor accommodates a sand storage and mixing space, a blower room and a large double core oven. It is double in the sense that it may be used in halves by closing a sliding partition midway of its length. A separate fireplace serves each half. The sliding partition and the doors at both ends of the core oven are of the Kinnear rolling iron type. Two tracks of standard gauge width extend through the oven from the core room to the foundry.

The two new cupolas are Paxson-Colliau type. The smaller one has a shell 63 in. in diameter and a capacity of 9 tons of metal per hour. The larger one has a 76-in. shell and a 14-ton per hour capacity. The blowers serving these cupolas are in the room set apart for that purpose under the charging floor and, being near by, the pipe lines are short. The smaller blower has a capacity of 22 cubic feet per revolution, and is driven at a speed of 225 revolutions per minute by a 35 h.p. Westinghouse motor. The larger blower has a capacity of 35 cubic feet per revolution, and runs at 200 revolutions per minute, being driven by a 50 h.p. Westinghouse motor. Five ladles of various sizes are on hand for use according to the requirements, the two largest being of 15 tons capacity each.

The outdoor crane at the rear of the building is a 5-ton Shaw electric crane, and covers a span of 40 ft. In addition to serving the trestle and charging platform in the yard beneath it it is used for breaking castings, a large weight being raised by means of the hoist and dropped upon the casting to be broken.

Among the interesting machines in the foundry is a magnetic separator, built by the Dings Electro Magnetic Separator Company. It is used to recover the available iron from cupola cinder, gangway scrapings, chipping room dirt and foundry offal. The machine has a capacity of 100 to 150 cubic feet per hour, or as fast as one man will naturally shovel the material, and is driven by a ½ h.p. contained motor, making it possible to shift its location at any time with little trouble. The separator consists of a cylinder inclined from its inlet to its discharge end, and is of wire screen with the exception of a solid part of brass near the discharge end, where all the fine dirt has been separated from the material. Through this brass ring the poles of numerous electro magnets project. These are automatically magnetised while passing under the work and demagnetised at the highest point of their travel, dropping the iron which has been raised with them into a chute extending out from the open end. The cylinder is high enough from

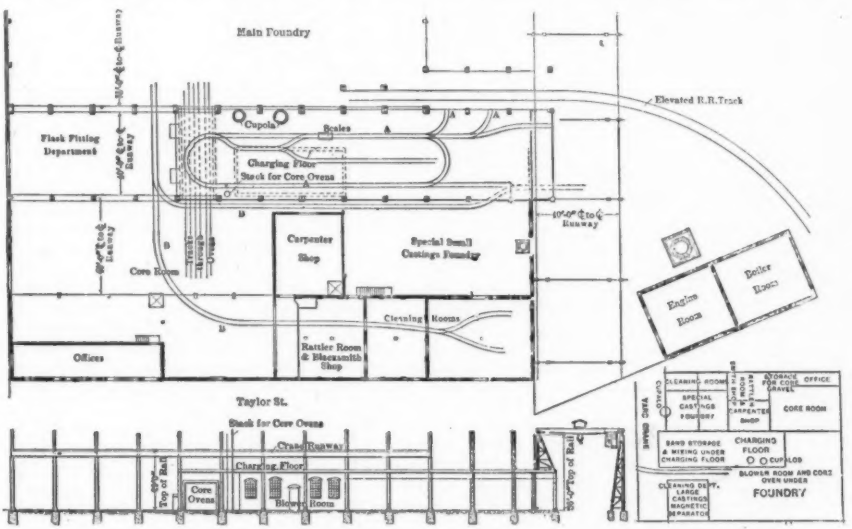


FIG. 1.—PLAN AND PART ELEVATION OF FOUNDRY BUILDING.

FIG. 2.—PLAN OF GENERAL ARRANGEMENT.

the floor to permit wheelbarrows to be placed underneath to receive the different separations, and yet is low enough to permit of conveniently shovelling the material into the machine from the floor. It requires only about ¾ h.p. for both its electrical and mechanical operation, and makes three separations—sand, coke, and iron. The pieces of coke, slag, and non-magnetic material too large to pass the screen are delivered from the end of the cylinder into a chute extending under the separator.

Another interesting machine is a portable mould dryer built by Thomas Shedden & Sons of Paisley, Scotland. It is arranged to be placed directly over the mould to be dried, and contains a coke furnace, through which a draft of air is forced by a Buffalo Forge Company's motor driven blower. The air is directed down into the mould and escapes through the runners.

The old wing contains the small castings foundry, cleaning rooms, a blacksmith shop, a carpenter shop and the core department. That section lying between the core department and the large foundry opposite the end of the charging platform is served by an electric 10-ton crane of 40-ft. span. This space is used for fitting up flasks. On all large castings and on smaller standard work heavy iron flasks are used, which reduce the danger of accidents and produce work true to the patterns. These flasks are built upon a unit system, and consist of standard cast iron sections, flanged at their edges and bolted together. From them may be assembled flasks of any height or rectangular dimensions in even foot units. A large stock of these flask parts has been made a feature of the foundry equipment. The core room proper contains a 5-ton crane of 46-ft. span. The blacksmith shop and carpenter shop are used only for such work in their lines as is required in the foundry, such as the making of flasks or flask parts, wrought iron clamps and reinforcing pieces, etc. The smith shop contains a forge, and a rattler and emery wheels, which are accessories to the cleaning department. The rattler and emery wheels are belted from a short line shaft, which is driven by a 25 h.p. motor.

The small castings foundry uses an old 50-in. cupola, and contains a hand jib crane, both of which were left in place at the time alterations were made. In this department it is the intention to use moulding machines for as much of the work as possible.

Adjoining the small castings foundry in the space under the charging platform is the sand storage and mixing department serving both foundries. A sand sifter is installed in this space, which consists of two revolving screens of hexagonal cross section, ½-in. mesh, overhung on a shaft which is driven at the centre through a worm and worm wheel by belt from a ¾ h.p. motor. The outer ends are open to receive the sand, and the inner ends are closed, and carry cams operating bell crank bumpers, which jar the screens and detach all the dirt adhering in the meshes.

Pattern Shop and Storage.

The pattern shop and storage building contains two stories and a basement, wherein all the line shafting and countershafts for the power using machinery except the cranes is located. The pattern shop is on the main floor, and all the machines, including a band saw, jointer, circular saw, surfacer and two lathes, are belted through the floor to their respective countershafts beneath. The power is furnished by a 35 h.p. Westinghouse motor direct connected to the line shaft. The second floor is the pattern storage. One 2½-ton crane with electric hoists and hand travel, handles the heavier patterns, and two other cranes of same make and size serve the pattern shop. For lifting patterns from the main floor to the storage floor the upstairs crane is used. There is a section of the floor near the rear of the building which is removable for this purpose. The large covers which close it are easily removed by the crane and set to one side while transfers are being made.

A systematic proceeding marks the handling and storage of the patterns in the pattern storage building. The smaller patterns are placed on racks, which are numbered and lettered, and a record is kept of the location of each pattern, and whether or not it is in use. When a pattern is called for by the foundry it is taken from the racks in the storehouse and placed in a rack in the foundry. After the pattern has been used it is placed in another rack, which is marked "For Finished Work," and from there it is returned to the storehouse. We are indebted to the "Iron Age" for the above particulars.

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THE BRITISH ENGINEERING COMPANY OF EGYPT, LIMITED, has been formed for the representation in Egypt of Dick, Kerr & Company, Limited, Callender's Cable and Construction Company, Limited, Babcock & Wilcox, Limited, Gwynnes, Limited, and Jas. Gibb & Company.

CHARACTERISTICS WHICH MAKE IRON VALUABLE.

The chief characteristics which make iron valuable are its softness, its fluidity, and its low shrinkage. These three properties are dependent upon the solution of the carbon and iron.

We have been repeatedly told in stereotyped phrases that combined carbon hardens iron and that graphitic carbon softens iron. In considering the reason for the softness of cast iron we must take silicon into consideration. Graphitic carbon is formed by a separation of carbon from the iron as it cools, due to the fact that the iron can hold only so much carbon is solution at a certain temperature, and that when the iron is cold it can hold but a comparatively small amount in combination. By introducing the element silicon we find that the same softness in cast iron can be produced with lower carbon. This is due to the fact that iron which contains silicon will hold less carbon in solution. Consequently, two irons which contain the same carbon and different silicon will vary in softness. The iron which contains the most silicon will have more of its carbon in the graphitic state. Pure iron will hold in solution in the solid state about 1 per cent. of carbon. This is the so-called combined carbon which hardens iron. Irons containing silicon will hold less carbon in the combined state, and in this manner silicon acts as an important factor in softening iron.

Graphitic carbon softens iron first because it serves to destroy the continuity of the iron, making it less dense and easier to penetrate, and, second, because it acts as a lubricant to the tool which is used for cutting it.

Fluidity.

Fluidity of cast iron refers to the length of time that the iron will remain liquid. The fluidity of a substance is to a large extent a question of temperature. The prolongation of this fluidity is a question of composition.

When carbon dissolves in iron latent heat must be supplied to the carbon to change its condition. Heat must be furnished to melt iron and for every unit of heat applied there is a corresponding rise in the temperature of the iron. The latent heat which is used up in changing the solid carbon into dissolved carbon causes no rise in temperature. It is the same heat absorbed in the change of water to steam.

All molten cast iron contains carbon in solution. Heat has been rendered latent in dissolving this carbon and heat must be given up when this carbon separates from solution. As cast iron cools its ability to hold carbon in solution decreases and the carbon separates out. As it separates out the heat which was rendered latent by its solution is given up. This will account for the fluidity of cast iron. In the first place iron will live longer in the ladle than will steel, due to the fact that the carbon gradually separates out as the iron cools and gives up its latent heat, which prolongs the cooling of the iron. The more important action, however, takes place during casting. When the iron comes in contact with the sides of the mould, the latter takes heat from the iron, thus lowering its temperature. At the moment the temperature is lowered carbon separates out of the iron, and in separating out gives up heat. This heat prolongs the fluidity of the iron just at the instant when it requires this fluidity to fill the smallest corners of the mould.

Shrinkage.

Shrinkage and lack of shrinkage in cast iron are accounted for by the relation of carbon to iron. Cast steel contains a comparatively small amount of carbon; cast iron contains carbon up to 4 per cent. The chief difference in their composition is in the amount of carbon and silicon they contain. Cast steel shrinks much more than cast iron. Inasmuch as the chief difference in composition is a difference in the carbon and silicon present, we can safely consider that the variation in shrinkage must be due to this cause.

As the molten steel comes in contact with the mould it solidifies, forming a shell the shape of the mould. This shell will rapidly grow thicker as the steel cools. But inasmuch as the steel in a hot molten state occupies more space than it does in a cold solid state, there would be left in the inside of the casting a cavity the size of which would be equal to the difference between the volume of the molten steel and the volume of the cold steel. This is not exactly correct, however, as the contraction which sets in as soon as the shell forms on the outside of the casting somewhat reduces this internal shrinkage.

Cast iron acts in a similar manner when poured into a mould. The iron sets, taking the conform of the mould. This shell increases in thickness as the iron

* From a paper by H. E. Field, before the New England Foundrymen's Association.

cools, but in place of the uniform product noted in steel we will have a mixture of graphitic carbon and iron due to the separation of the graphitic carbon from the iron in cooling. The specific gravity of cast iron decreases as the percentage of graphitic carbon increases, or, in other words, the weight of a unit volume of cast iron will be less as the percentage of graphitic carbon increases. Conversely, then, a unit weight of cast iron will occupy more space as the percentage of free carbon increases. The slower the cast iron cools the greater will be the proportion of carbon separating out as graphitic carbon. The rate of cooling depends upon the rapidity with which the surrounding mould will conduct away the heat. After the iron is cast into the mould the mould will gradually heat up and the hotter it gets the more slowly will it conduct away the heat from the casting. The shell formed on the casting helps to keep the inside of the casting hot and it will therefore cool more and more slowly as it cools from the outside toward the centre. Consequently, more and more carbon will be found in the graphitic condition as we near the centre. We find, therefore, that the graphite separating out in the centre of the casting takes up more room than would the iron without the graphite and thus tends to fill up the hole which would otherwise have been formed in the cooling of the iron.

Silicon aids in reducing shrinkage by its action in forcing graphitic carbon out of solution. Its effect is therefore indirect. An excess of silicon over the amount necessary to force the desired amount of carbon out of solution would tend to increase rather than to decrease the shrinkage.

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PATTERNS AND METAL DISTRIBUTION.—It is of great importance to so proportion a pattern that the metal will be distributed so as to meet all the strains likely to be caused by the machine of which the casting is to be a part. In addition to this, it must be remembered that patterns constructed solely in accordance with that idea would, in some cases, be of no use whatever, as they could not be cast from and perfect castings secured. This means that the internal strains of a mass of cooling iron must be considered and provision made for meeting and absorbing such strains. It is then sometimes necessary to put in much more iron than strength requires, in order to secure a casting that will not crack in cooling.

NOTES ON LUTES AND CEMENTS.*

From a recent paper by Mr. Samuel S. Sadtler we extract the following:—

Lutes and cements may be classified as follows:—

1. Water- and steam-proof.
2. Oil-proof.
3. Elastic.
4. General purposes.
5. Marine glue.
6. Gaskets.
7. Machinists'.
8. Leather (belting).
9. Crucible, iron, and stone.
10. Core compounds.

1. *Water-Proof Compositions.*—Of use to engineers are the asphalt fluid coatings. Asphalt is entirely soluble in benzol or toluol, which are about its cheapest solvents. Tar and pitch are sometimes used in this connection, but they contain impurities. The asphalt alone is somewhat pervious to water, and this is improved by adding about one-fourth its weight of paraffin, and made better if in addition a little boiled linseed oil is added also. For thicker compositions, where body is required, asbestos, stone powder, cement, etc., may be added as fillers.

Lutes of linseed oil thickened with clay, asbestos, red or white lead, etc., are waterproof if made thick enough. These are much used for steam joints.

2. *Oil-Proof.*—The most useful lute for small leaks, etc., is the well-known "hektograph composition," as follows:—Good glue or gelatine, 2 parts; glycerine, 1 part; water, 7 parts. This is applied warm and stiffens quickly on cooling. Another very useful composition is a stiff paste of molasses and flour. One of the strongest cements, and one which is really oil-proof, water-proof, acid-proof, and proof to almost everything, is a stiff paste of glycerine and litharge. If a little water is added, it sets more slowly, which is often an advantage. A solution of silicate of soda made into a stiff paste with carbonate of lime, gets hard in six to eight hours.

3. *Elastic Cements.*—The various cements containing rubber are elastic, if it is in predominating amount. The most useful single rubber lute is probably the so-called Hart's india-rubber cement. Equal parts of raw linseed oil and pure masticated rubber are digested together by heating and this mixture made into a stiff putty with fine "paper stock" asbestos. It is more convenient, however, to dissolve the

* Engineers' Club of Philadelphia.

rubber first in carbon disulphide, and after mixing the oil with it, to let the solvent evaporate spontaneously.

4. *General Purposes.*—One of the most useful is plaster of Paris, and especially when mixed with asbestos, straw, flush trimmings, hair, broken stone, etc., used according to temperature, strain, and other conditions. A putty of flour and molasses is a good composition to keep in a works ready for quick application when needed. It serves almost any purpose at moderate temperatures for a time. Casein compositions have great strength.

5. *Marine Glue.*—This can be purchased almost as cheaply as made.

6. *Gasket Compositions.*—Of course, almost any cementing substance may be used with rings of asbestos. etc., for gaskets. but there are some to choose especially for that purpose.

With regard to asphalt, tar. pitch, and petroleum residum. the author recommends soft or hard pitch, as may be desired, because there are no light oils or water to go off at low heats. and the free carbon and compounds very high in carbon are good fillers to asbestos gaskets at high temperatures. Silicate of soda by itself is much used, but is sometimes advantageously mixed with casein, fine sand, clay, asbestos, carbonate of lime, caustic lime, magnesia, oxides of heavy metals, such as lead, zinc, and iron, and powdered barytes. A few that might be selected are —silicate of soda and asbestos; silicate of soda and fine sand; silicate of soda and fire-clay.

7. *Machinists' Cements.*—These are the well-known red and white leads. The red lead is often diluted with an equal bulk of silica or other inert substance so as to make it less powdery. The best way to do this, however, is to add rubber or gutta-percha to the oil as follows:—Linseed oil, 6 parts by weight; rubber or gutta-percha, 1 part by weight. The rubber or gutta-percha is dissolved in sufficient carbon disulphide to give it the consistency of molasses, mixed with the oil, and left exposed to the air for about twenty-four hours. The red lead is then mixed to a putty. Oxide of iron makes a less brittle cement than red lead. Probably fish oils and red lead would make good lutes of the class for joining pipes, as the fish oils are not such strong drying oils as linseed, and their use might be a case of permissible substitution rather than adulteration.

8. *Leather Cements.*—(For leather belting.) This subject is treated fully and well in various books.

9. *So-called Iron, Stone, and Crucible Cements.*—These are all hard, stone-like compositions. The oxychloride cements, consisting essentially of oxychlorides of magnesium and zinc, are very hard and are much used in engineering construction.

Stone Cements.—Two formulæ are:—Zinc oxide or magnesium oxide, 2 parts; zinc or magnesium chloride, 1 part; water to make a paste.

When dry, these become very hard and strong. Powdered stone is generally used as a diluent.

Iron Cements.—When iron in a fine state of division, as in fresh filings or cast-iron borings that have been powdered, is mixed with an oxidising agent, such as manganese dioxide or a substance electro-negative to iron, such as sulphur, in a good conducting solution like salt of salammoniac, galvanic action sets in very rapidly, and the iron swells, by forming iron oxide, and cements the mass together. It is best diluted with Portland cement. A formulæ from memory is:—Iron filings, 40 parts; manganese dioxide, or flowers of sulphur, 10 parts; salammoniac, 1 part; Portland cement, 20 to 40 parts; water to form a paste. These cements are used extensively in foundries.

Crucible Cements.—Mixtures of clay and borax in which the clay predominates. Silicate of soda and powdered glass or sand are the best known compounds for cementing lids on crucibles, etc. Sometimes the "iron cements" are used for such purposes, or iron filings and a little manganese dioxide are added to the above compositions for crucible cements.

10. *Core Compounds.*—Some of the substances suitable are: Dextrin, spoiled potatoes, grain and starchy materials, molasses, glucose, clay, sand, loams, bituminous coal, pitch, asphalt and tar, oxychloride cement and Portland cement. Most of these have been used as core compounds, those most advantageously employed being probably flour, or meal of some kind, dextrin and molasses.

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Forging Rolls.—Forging rolls are now used for making many articles in whole or in part formerly made on hammers such as fork tines, brake shoe keys, horse nails, harrow discs, sucker rod joint straps, tapering plough beams, ends of springs, etc. A piece of work may be instanced in which a bar 1 by ½ in. had 7½ in. of it drawn to a length of 16 in. at a single pass in eccentric rolls, most of its cross section being reduced to ¼ by 1⅝ in., the actual time of contact being less than one-half second. The same work under a hammer would have taken many times as long. The die face line of travel in these rolls was 14 in. diameter and the speed very high.

THE EXHAUST SYSTEM OF DUST COLLECTING AS APPLIED TO GRINDING MACHINERY, ETC. *

By Vernon I. Norbury Williams
(Manchester).

There are at the present time many manufacturing firms using grinding machines of all classes, who, while in other respects quite up-to-date, have not as yet adopted in their works the exhaust system of dust collecting, the merits of which it is the desire of the author to bring forward in this paper. It is now no longer necessary to conduct grinding operations in a dust-laden atmosphere with the consequent evil effects on both operator and machine, as the dust is drawn away along the pipes immediately it is produced.

The system has proved a valuable one: (1) In satisfying the conditions laid down in the Factory Acts relating to emery grinding processes, etc. (2) In prolonging the life of a machine which would otherwise become inaccurate, owing to the emery working itself into the slides and bearings.

In laying out an exhaust system for grinding machines, sand-blast apparatus, etc., it is essential in the first place to decide :—(*a*) The total number of machines to be served, and their position with regard to the fan. (*b*) The diameter of service pipe required to each machine. (*c*) The number of machines which it is probable will require serving at any one time. (*d*) The type of exhauster to be used and method of driving. (*e*) The form of dust collector to be used outside the building.

(*a*) In deciding the number of machines which shall be served, it is advantageous to allow for a certain reserve. If the reserve were not allowed for, and at some future time it became necessary to add more machines, the efficiency of the system might become seriously impaired and occasion a large deposit of emery in the pipes.

(*b*) It will be found that a 6-in. pipe is sufficiently large for the heavier grinding machines, while a 4-in. pipe will efficiently serve the smaller. Of course, each machine must be fitted with a hood or guard which is exactly suited to its particular functions. If this is not done, a great deal of the suction will be lost.

(*c*) It is advisable to form some sort of an estimate of the number of machines likely to be running at one time. If the system were designed to take all the machines at once, it would be needlessly large in the majority of cases, as it is more likely than not that from 15 to 20 per cent. of the machines are idle.

(*d*) The exhauster fan is an important part of the system. It should be stiffly built, well balanced, free from excessive vibration, and capable of running for long periods without attention. This last requirement is usually provided for by the use of oil-ring bearings. There are numbers of well-made fans on the market embodying these features and designed practically on the same lines. The circular inlet is at one side of the spirally-formed fan-case, and concentric with the

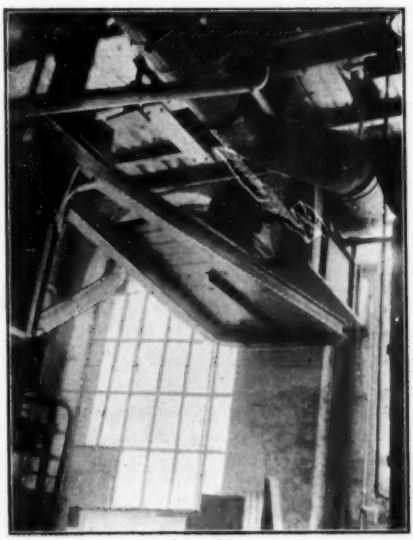

Fig. 1.

fan-shaft, the two bearings for which are usually placed at the opposite side and outside the casing. In the particular system herein described, the fan was provided with one bearing on either side of the casing. There may be a slight advantage in the former arrangement, as far as the free passage of air through the inlet is concerned, but the author is of opinion that this is more than counterbalanced by the sweeter running and freedom from vibration obtained in the latter case. In the exhausting of wood-working refuse, shavings, etc., the latter arrangement would obstruct the passage of the shavings into the fan. It is, of course, impracticable where the centre line of the main exhaust pipe to the fan is a continuation of the fan-shaft axis, but in the

*Paper read before a graduates' meeting of the Institution of Mechanical Engineers.

system described it will be seen that the piping arrangement readily admits of it. The discharge opening is rectangular and tangential to the body of the fan, and it

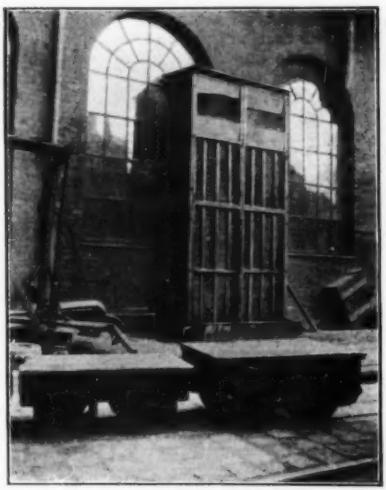

FIG 2.

is advantageous to fit it with a fine water-spray, the water from which, becoming well mixed with the dust by the action of the vanes, helps to deposit it in the outside collector. The fan, which ought to be provided with an access door in order that any sediment or obstruction may be cleared away periodically, can be either belt-driven or direct-driven by motor (see Fig. 1), using some form of flexible coupling to take up any error in alignment. The latter method is preferable, requiring as it does a much less platform space. In the system described it will be observed from Fig. 1 that advantage has been taken of the fact that large windows cover one end of the room in which the fan is placed, the brick pillar between two adjacent windows being utilised as the main support for the steel fan platform, and a pane of one of the windows removed to allow the fan discharge to pass through. The motor should have about 20 per cent. reserve power, that it may be able to meet any additional work in the way of new machines added to the system, and should be enclosed as a protection from dust.

(*e*) There are several forms of outside collectors in use, probably the simplest being a pit or box into which the dust is blown, being allowed to settle by gravity alone. Another form is that of a pit or sump, the bottom being filled with water to arrest the dust, but the author's experience of this is that the water surface is very soon covered over with a layer of dry dust, and the collector then becomes non-effective. Probably the best form is that of a teak shed standing in a large galvanised iron trough, the front of the shed being provided with a double filtering screen of moderately fine linen gauze, backed up by a layer of hemp matting with ½-in. square mesh (as shown in Fig. 2). A perforated copper pipe is laid across the top of the shed inside, with the perforations directed towards the screen. The pipe being supplied with water, there is a continuous sheet of spray forced against the screen, trickling down the face into the trough, and on its way gathering the dust from the discharged air which is passing through the screen. The dust is washed down into the trough as a fine mud, and may be removed from time to time. If there is no sand-blast chamber to exhaust, and very few machines to be served, there is no need for a collector, the dust being simply blown into the air.

In the laying out of the piping, care must be exercised that the areas of the various mains and connections are such that a fairly uniform velocity of air is maintained in them all. A fall in velocity

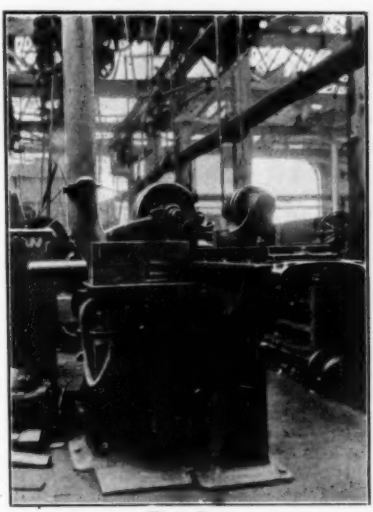

FIG. 3.

at any part of the system results in a consequent deposit of dust. On this basis the area of the main as it enters the fan must be equal to the sum of the areas of all the active branches and connections

plus the reserve. In a system accurately laid out in this way, the intensity of the suction in the service pipe farthest away from the fan is practically equal to that

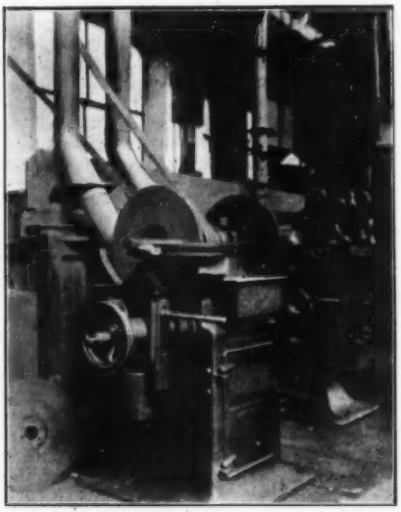

FIG. 4.

in close proximity to it. The junctions of the service-pipes and branches should be a bend in the direction of suction in every case.

With regard to the arrangement of service-pipes to the various machines, this depends in a great measure on what position the room occupies in which the machines are placed. The author favours the overhead service, as the main can be safely laid along the beams carrying the countershafting of the machines, and the vertical service-pipe is easily accessible and out of the way of the operator. "Catch pits" should be provided on the underside of the piping near every junction of a branch with the main, and at intervals along the main. This allows of access for cleaning purposes and removal of obstructions. The service-pipe is carried to such a point on the machine as will be most convenient for the fixing of the special hood or guard, and where it is not likely to be disturbed at any time. There are instances of flexible piping being used to connect the hood on the machine with the overhead branch, and it is possible that this method is an efficient one in particular cases; but the author is of opinion that in the great majority of cases which the different types of grinding machines present, the straight metal pipe will be found to be the handiest, more durable, and more convenient, provided it is brought down to the correct spot on the machine. It is advisable to fit the service-pipes just above the hoods with a slide valve, that they may be shut off when not in use.

In the designing of the hoods, each type of machine demands special treatment if all the dust given off is to be successfully drawn away. The remaining illustrations shown give a fair idea as to what is required for the various types usually found in a grinding department.

Fig. 3 shows a universal grinding machine with detachable hoods for external, internal, and face grinding. In the illustration a side view is given showing the attachment of the junction box to the tray of the machine.

Fig. 4 shows a disc surface grinder with two discs. The exhaust boxes under the discs are provided with a hinged flap, which allows of the discs being withdrawn from the spindle without interfering with the boxes.

Fig. 5 depicts two large buffing wheels. The hoods are provided with hinged tops which can be thrown over out of the way, to allow of long bars being passed across the faces of the wheels. The bases are also made that they may be readily removed for the replacing of a wheel.

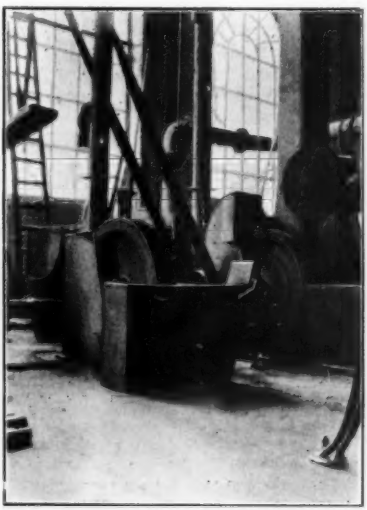

FIG. 5.

In the case of a sand-blast apparatus and acid hardening tank, a simple connection is made between the exhaust main and the apparatus, in the latter case the

pipe being connected to the apex of a conical-topped chamber in which the tank stands.

The following data of materials and construction relating to the particular system described may prove interesting:—Number of machines served, 10; fan inlet, 19 in. diameter; fan discharge, 19¾ in. by 10 in.; nominal h.p. of motor, 9; h.p. consumed with all machines exhausting, 6.8 (from ammeter and voltmeter readings); revolutions per minute of fan with all valves open, 775; average reading of water gauge, 1½ in.; material used for piping, hoods, etc., No. 20 B.W.G. best galvanised sheet; flanges up to 8 in. diameter, 1 in. by 1 in. by ⅛ in. mild steel angle; beyond 8 in. diameter, 1 in. by 1 in. by ¼ in. mild steel angle.

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EARLY IRON FOUNDING.

The first find of metal was a piece of iron, which was discovered in the foundations of an Egyptian pyramid, and must have dated from more than 3,000 years before the Christian era. The knowledge of cast iron, is, however, comparatively recent; in olden times only wrought iron was obtained from the ore, as indeed it still is in Asia and Africa. However skilful the ancients may have been in producing pig-iron, the knowledge of cast iron only dates from the beginning of the fifteenth century, and is first mentioned in the archives of Lille. The practical application of cast iron begins at the period when water power superseded manual labour for blowing the bellows. The art of moulding only required the transition from pig-iron to cast iron. Besides cannons, cannon balls were cast to replace the old stone projectiles, and their moulds were made of gypsum. The casting of iron directly from the blast furnace gradually opened up a wide field of applications. In 1685 the first cast-iron pipes were used for the water service of Versailles, followed by screwed and flanged pipes. In 1708 Darby, a Quaker, patented the system of box casting, and in the following year started the famous Coalbrookdale Foundry, which in 1780 turned out the first cast-iron bridge. About the same time malleable cast iron was invented in France, and was much advanced by Reaumur, who also perfected furnaces, which must be regarded as the forerunners of the Bessemer converter, and by means of which the casting of iron was emancipated from the blast furnace process. The English cupolas, first mentioned in 1764, were of German origin.

THE PYROMETER IN THE FOUNDRY.

Amongst the advances recently made in foundry practice there are few more striking than the introduction of pyrometers for ascertaining the temperatures at which metal is poured. In this, as in other departments of engineering, it is clear that varying results must be due to varying conditions, and that all the

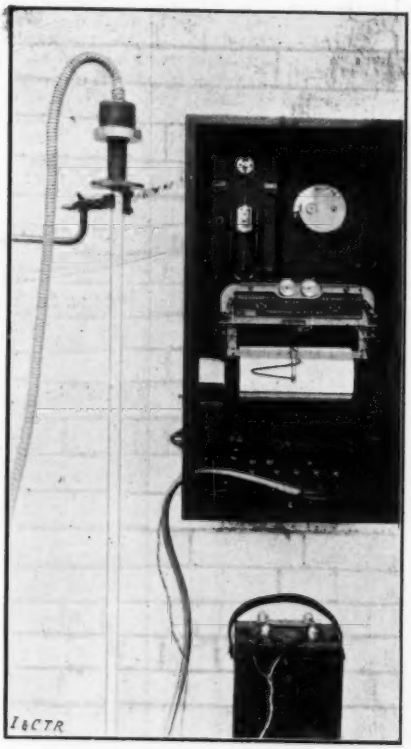


Fig. 3.—Callendar's Electrical Recorder.

conditions which determine the quality of the castings obtained must be closely studied and controlled if we wish to attain to more uniform success, to improve the general quality of the products, and to reduce the proportion of "wasters" to a minimum.

Apart from the many considerations which enter into the work of the moulder, it may be broadly stated that the prin-

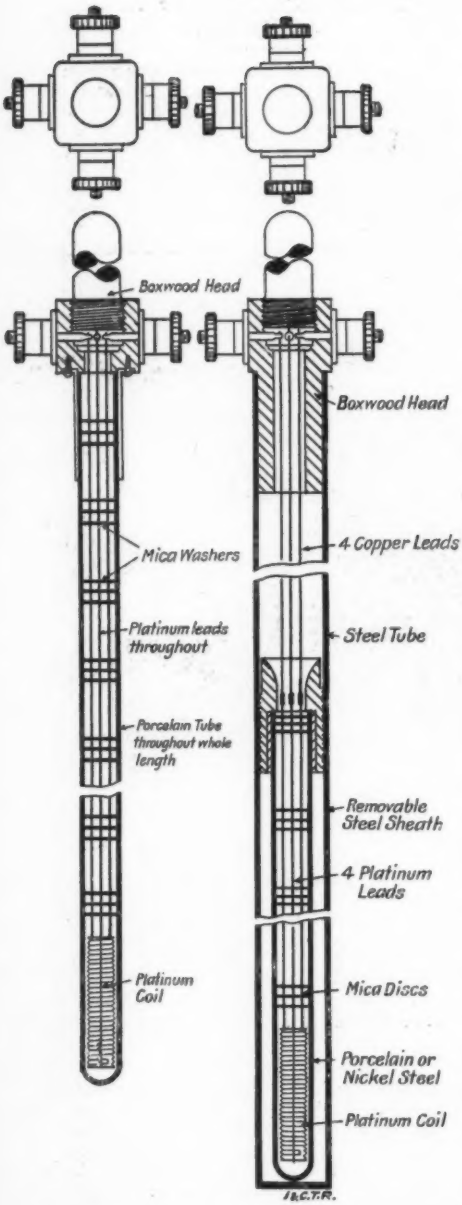


FIG. 1.—CALLENDAR & GRIFFITHS' PYROMETER, MADE BY THE CAMBRIDGE SCIENTIFIC INSTRUMENT CO., CAMBRIDGE.

cipal factors determining the properties of the cast metal are its chemical composition and the temperature at which it is poured.

The importance of knowing within narrow limits the chemical composition of the metal employed is now widely recognised, and the facilities for obtaining metal of definite guaranteed composition have so much increased of late that we do not need to turn aside from our subject to dwell on this aspect of the question: the use of pyrometers in the foundry as part of the ordinary routine is of more recent origin, and some account of what has so far been accomplished by this means may prove of interest.

In almost every case, metal which is poured at too low a temperature is deficient in fluidity, and the resulting troubles are so evident and disastrous that there is a natural tendency to overheat the metal sufficiently to leave a safe margin.

But in this case, as in others, a safe margin is often a dangerous thing. There is always a tendency for alloys to become poorer in the more volatile and combustible of the metals composing them, a tendency which is seriously aggravated by overheating. These losses (with consequent change of composition) take place to a considerable extent while the crucible is in the fire, but chiefly, perhaps, while the metal is being poured. Not only is the wastage more rapid at the higher temperature, but the crucible, in order to reach this temperature, has been allowed to remain longer than was necessary in the fire. The last-named trouble is not so marked where fresh lots of an alloy are being made up from its elements, the more volatile constituents being added last, but it may be serious where scrap is being melted down, or where ingots of the alloy used are charged into the crucible, or where for any reason the mixed metal has to remain hot for some time before pouring. Another evil, especially marked in the case of alloys containing aluminium or zinc, is the reduction of silicon from the silica of the crucible, and from the casting sand, the reduced silicon entering into combination with the alloy and rendering it brittle. Moreover, the moulds are more apt to be damaged by unduly heated metal, and to give off vapour which forms blowholes in the castings. To these should be added the excessive contraction of the overheated metal, and the greater length of time between pouring and solidification, during which segregation of the constituents can take place. The saving of fuel effected by casting systematically at

the right temperature, instead of overheating the metal, is another point which should be kept in mind.

All these considerations point clearly to the need for some practical method of gauging the temperature within the crucible; and of the methods so far proposed, the most sensitive, as well as the most reliable and convenient, is the platinum electrical thermometer. The essential feature of this instrument is a coil of fine platinum wire wound on a mica frame, and protected by a tube of fine refractory porcelain; this tube being in many cases further protected by an outer sheath of steel, which is not in contact with the porcelain, but separated from it by a small clearance. When the lower end of the thermometer is immersed in the molten metal, the steel sheath at once acquires the temperature of the latter, and the porcelain tube and platinum wire spiral likewise reach this temperature with hardly an appreciable lag. The heating of the platinum wire increases its electrical resistance, and so by means of a measurement based upon the resistance of the wire, the temperature which it has attained can easily be read.

The Cambridge Scientific Instrument Company, Limited, of Cambridge, make a variety of electrical resistance thermometers suitable for a wide range of industrial operations, two forms suitable for foundry use being shown in Fig. 1. These instruments are made under Callendar and Griffiths' patents.

The same firm make a special direct-reading temperature indicator (Whipple's Patent), which, in conjunction with one of these thermometers, enables temperatures to be read off upon a scale, without making any calculation and without referring to tables of values. See Fig. 2.

Such an installation is now in constant use in the brass- and gun-metal foundries at the Royal Arsenal, Woolwich. Any one of the various pyrometers in use in the foundry can be connected up to the direct-reading temperature-indicator by means of a switchboard.

In many applications of electrical thermometers, it is not sufficient to observe the temperature at one or more definite moments of time. In annealing, for example, it is necessary to have a continuous record of the temperature of the annealing furnace. This result is achieved by using, in conjunction with an electrical thermometer, a Callendar electric recorder. Such an instrument, together with the attached thermometer and battery for working the recorder, is shown in Fig. 3.

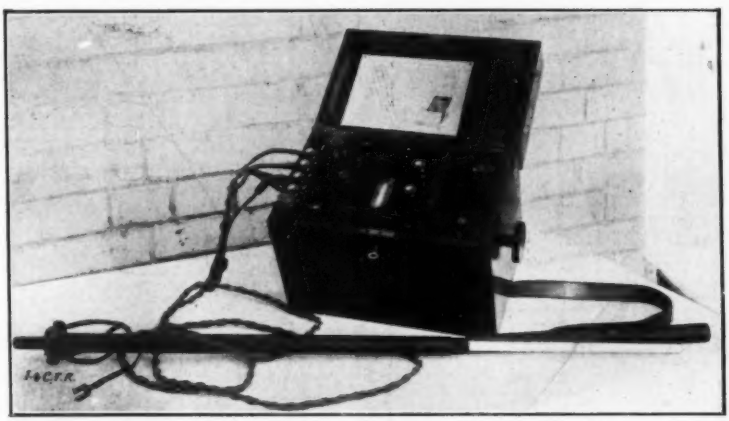


Fig. 2.—Whipple's Direct-Reading Temperature Indicator.

A continuous record can thus be obtained, drawn by a pen upon a paper-covered drum, so that the record is always open to inspection, and the temperature can at any time be read off without disturbing the registering of the instrument. It can thus be seen at a glance whether the required temperature is being maintained or not. The pen is actuated through clock-motors, controlled by a simple, yet highly sensitive, system

of electrical relays, so that the friction between the tracing point and the paper introduces no error whatever into the record obtained.

Fig. 4 is reproduced from an annealing furnace record obtained with a Callendar recorder, a marked change being shown in the character of the record where one stoker (A) went off duty and another (B) took his place.

Annealing is, of course, of the first importance to the makers of armature stampings; or of steel castings, and these electrical outfits have been found especially valuable in connection with such work. At the works of the Roe Steel Castings Company, West Drayton, the annealing furnace temperatures are

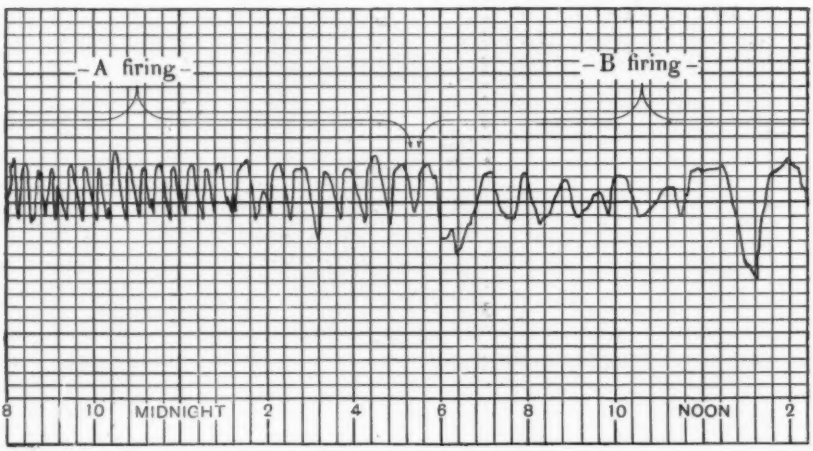


FIG. 4.—ANNEALING FURNACE RECORD MADE BY PYROMETER.

continuously registered by means of electrical resistance thermometers, working in conjunction with Callendar recorders. Another very elegant application of the Callendar recorder is in determining the recalescence point of steel.

In conclusion, the work done by Messrs. Heycock & Neville on the melting points and physical properties of alloys* should be mentioned. This important research, in which many different alloys were included, was carried out by means of the Callendar & Griffiths' electrical thermometers and Callendar s electric recorder.

* Heycock & Neville. Chem. Soc Journ. 1890 & 1895. Heycock & Neville Bakerian l ecture "On the Constitution of the Copner-Tin Series of Alloys." Phil: Trans. A., Vol. 202, 1903.

MOULDING A THREE - BLADE PROPELLER FROM A BROKEN CASTING.

By W. PETERS.

THE following description of how we moulded a three-blade propeller from a broken casting may be of some little interest to your readers as a sample of a time and labour-saving scheme. The broken casting was an old propeller with only one full blade, the other two being broken off at the root. The diameter was 8 ft. and pitch 10 ft. As the author only intends to treat this article as a "principle," there will be no necessity for going into small details such as any average moulder is already conversant with, and which he would know was necessary.

In the first place a hole was made in the sand about 10 ft. diameter and 2 ft. deep, bedded in the usual way with coke for vent. The short spindle with its socket was fixed in at the same time. The sweep board A, Fig. 1, was next attached to the spindle, the board having a pin on its under side. We used a screw with the head filed off to mark off a circle, the diameter suiting the lowest point of the blades when in position.

After the bed was levelled up the board was removed from the spindle. The spindle being left in, the circle already made and shown at A, Fig. 2, was then divided into three equal parts.

Whilst the moulder was getting his bed ready, the pattern-maker was fitting into the bore of the boss a block of wood with a hole cut out to suit the spindle diameter, and also was getting ready the facings to make up for contraction and machining on the boss faces.

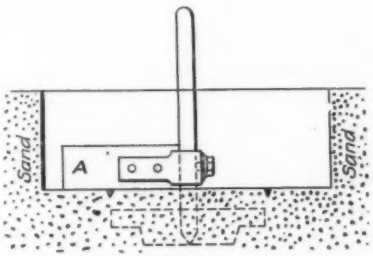


FIG. 1.

The broken casting was then placed on the spindle, care being taken to have the edge of the blade touching one of the division marks previously mentioned. Before releasing the crane we packed under the boss, and rammed hard to prevent settling. We then made up the bed at the back of the whole blade, and also found it necessary to make a joint from the boss centre to the top edge of the blade. This was made as a small drawback B, Figs. 2 and 3, and was then

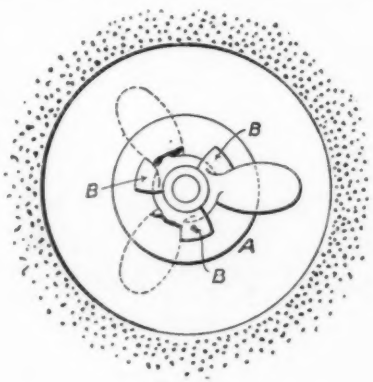


FIG. 2.

taken away to enable the casting, which was now the pattern, to be drawn, but before doing this we marked the shape of the blade on the bed. The pattern was then moved round on the spindle until the blade touched the next division mark, the former process being repeated; and then again for the third one. Here the pattern remained until the two broken blades were made good in the following manner:—The pattern-maker had made a set of thickness strips and these were set on one of the beds, Fig. 3, which had been covered with facing sand, and the moulder then proceeded as in the case of a loam mould, *i.e.*, sand was filled in between the strips, and the shape and thickness of the blades was thus formed in sand; this was repeated for the second one, and, of course, the third was already formed by the old casting; the contraction was allowed for by extending the blade points the required amount. Clay was used on the point of the pattern.

The three drawbacks forming the corners between the blade edge and the boss centre were then placed in position, facing sand was put all over the surfaces, and the cope placed on and staked. In

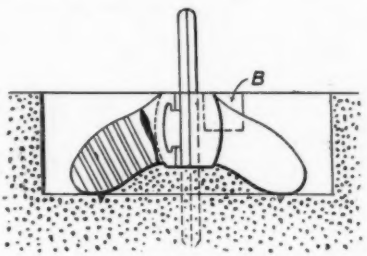
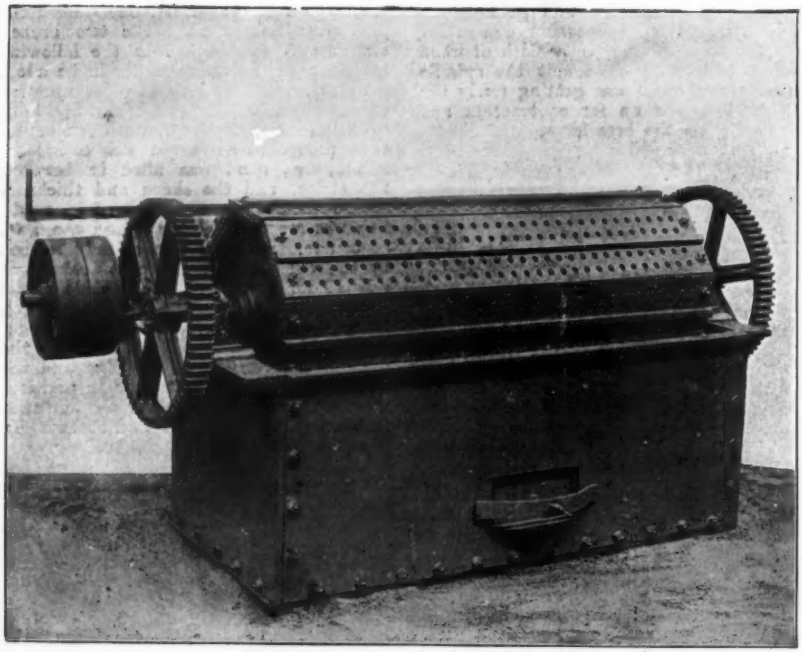
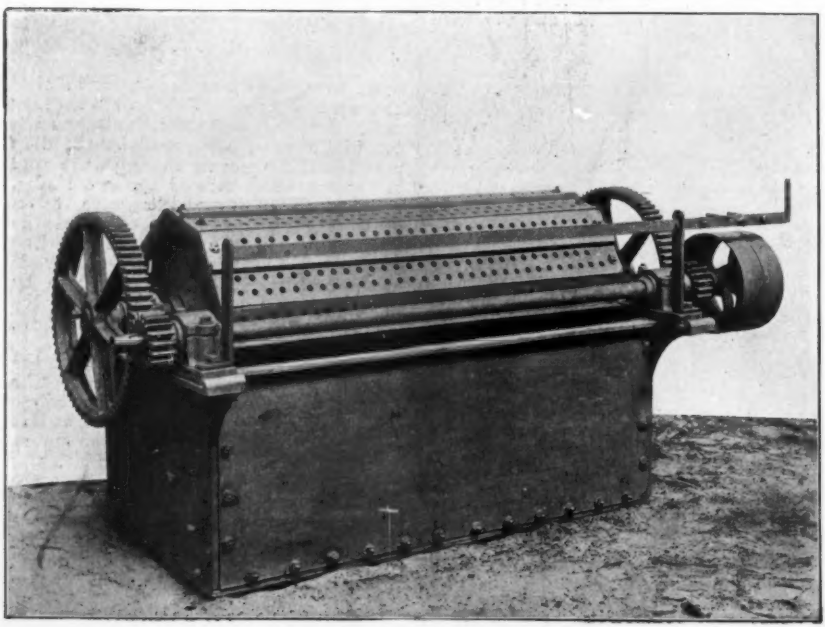


FIG. 3.

our case we used a square box and staked the four corners. The cope was then rammed up, long gaggers, hooked to the top of the bars, being used for the deep parts. After removing the cope, the sand and strips which formed the two blades, and the three drawbacks were taken away, the pattern drawn out, and the drawbacks replaced, but not fixed. The mould was then finished off and made ready for drying. This was done by replacing the cope and using one of the patent air drying stoves which we have in use.

The boss centre core was made in the usual way, that is, from a board. The reason for not fixing the drawbacks before the core is ready will be apparent, as this core cannot be placed in position unless they are moved. The spindle, which was still in its place, was used for setting the core, thus ensuring it being quite central with the rest of the work. The cope was then replaced and weighted, and after the runner box was fixed it was run through the boss and the mould was ready for casting.





THE WELLS WATER TUMBLER.

THE WELLS WATER TUMBLER.

THE Wells water tumbler, which is illustrated in the annexed cut, provides a most effective method for cleaning castings, giving a result superior to pickling, scratch brushing, or sand blasting at a lower cost. As there is no dust released by the process, the expense of dust exhausting ducts and exhaust fans is entirely saved. The tumbler revolves in a tank of water, the sand and dirt being washed out as the tumbler revolves. The water circulates freely through the perforation in the staves. Hard iron stars of various sizes, depending upon the class of casting, are kept in the tumbler, and these revolving with the castings being cleaned, effectively fettle them.

The tumbler is made in three sizes, the tumbling barrel in the smallest being 2 ft. 1 in. long by 1 ft. 3 in. in diameter. This is an ungeared type of tumbler. The two larger sizes are double-geared, the largest size having a barrel 6 ft. long and 2 ft. in diameter.

This tumbler is, of course, suitable to both brass and ironfounders. It provides, perhaps, the best method that has been devised of fettling castings without injury or inconvenience to the workmen employed. No dust gets into the atmosphere, and the process is clean, quick, and economical, the castings produced being thoroughly cleansed from all trace of sand. The tumbler is being placed on the market by Messrs. J. W. Jackman & Company, of 39, Victoria Street, London, S.W.

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AIR FURNACES.—The favour with which the air furnace is being looked upon for regular foundry work is, according to Dr. Moldenke, rapidly growing. He says:—"The additional cost of the process is easily counterbalanced by the superior work turned out. One large establishment is beginning to make all its engine castings in this way, and I know of many places where the substitution of furnace iron for the cupola product would mean longer life for castings which must be made out of cast iron to be used at all. Founders might therefore give this matter some attention in the near future. It means improving their product in that it keeps the metal from contact with the solid fuel, means less sulphur, less total carbon, greater uniformity in the metal; in fact, all the advantages which gun iron has over the ordinary run of cupola work."

AN ELBOW PATTERN

THE following is a simple method by which to lay out the pattern for a square elbow; that is, a right angle elbow in two pieces, and while it is only a rule-of-thumb method it will be found to approximate so closely to a correct method, that any trimming after it is formed up is altogether unnecessary.

Fig. 1 is not at all essential to laying out the pattern by this method, but is reproduced here to show where the different points are to be taken from. Fig. 2 is the pattern.

In laying out the pattern, lay off the circumference and divide into four equal spaces, 1, 2, 3, 4, Fig. 2, and draw division lines *a*, *b*, *c*, laying off any lap you may want outside of *a* at each end; set off the length of the throat *a f*, Fig. 1, on *a f*, Fig. 2; the distance *b g*, Fig. 1, on *b g*, Fig. 2; and the distance *c h*, Fig. 1, on *c h*, Fig. 2; then through the

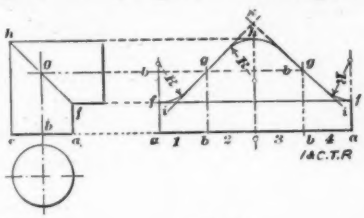


FIG. 1.

FIG. 2.

points *g* on *b g*, Fig. 2, draw the lines *i k* at an angle of 45 degrees; then with a radius *R* of about four-fifths of a space *a b*, or *b c*, strike an arc through the point *h*, which will be tangent to the lines *i k*; if this radius does not cut through the point *h* and be tangent to the lines as shown, it should be changed until it does.

Having found the correct radius for the centre part use it to strike the throat curves through the points *f* and tangent to the lines *i k* as before; then after adding any further laps that may be required the pattern is complete.

The pattern can be laid out without the use of Fig. 1 as follows:—Referring only to Fig. 2, lay off the circumference and divide it into four equal spaces as before, set off the height of the throat on *a f*, as may be required; then set off the diameter upward from *f* to *h*, divide this diameter into two equal spaces, and draw a horizontal line *l* through the centre, and where this line intersects the line *b g*, the points *g* will be established; then proceed as before by drawing the lines *i h* through the points *g* at an angle of 45 degrees, and taking the same radius strike the curves, add the laps and the pattern is complete.

HAYDOCK'S INTERCHANGEABLE BENCH PLANE FOR PATTERN-MAKERS.

In last month's issue of the FOUNDRY TRADE JOURNAL, the disadvantages of the V-shaped core box plane were pointed out, and a short description of the above plane may be of interest to our readers, as it is an improvement over the old-fashioned pattern-makers' loose sole plane for all kinds of curved work, as well as for semi-circular core boxes. Of course, the principle of having a loose sole fastened to wood planes probably dates back ever since the early days of making wood patterns, and cannot therefore be claimed as new. But it has many drawbacks. One of these is that the body of the plane is all wood. A second is the old-fashioned wooden wedge for fastening in the iron, and a third is the lack of a speedy adjustment for this wedge.

The plane illustrated herewith has been designed to overcome these defects. The body and all other cast parts are malleable iron, while the working parts are made of mild steel, and can be used with ordinary single or double irons as required. There is also an improved stop to slide in the key hole slots of the iron plane, which both takes up any blow or excessive thrust the plane may receive on the end of the wood sole plate, and also draws the wood sole plate tight to the face of the metallic stock. The accompanying plan and section through the centre of the plane illustrates this. As shown in Fig. 2, one quarter turn of the screw J gives the iron $\frac{1}{10}$th of an inch forward or backward adjustment. The

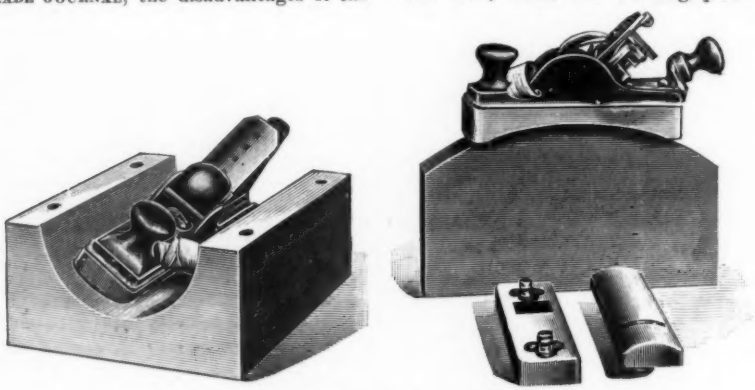


FIG. 1.—HAYDOCK'S INTERCHANGEABLE BENCH PLANE.

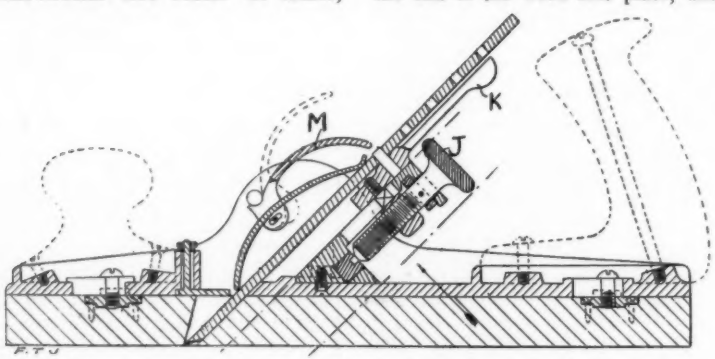


FIG. 2.—HAYDOCK'S BENCH PLANE—ELEVATION.

lever K adjusts the iron laterally or sideways, whilst to set the iron tight on its bed the cam M is depressed.

The V-core box plane is confined in its usefulness to a small semi-circular core box, and could not be used for any other purpose. It is claimed that this plane will work almost any shape required in pattern-making, and can be instantly changed or adjusted by a boy from flat to concave or convex-shaped work as required. A boy or any ordinary workman can make a special sole plate for any special shape required in a few minutes, and one iron will work, without regrinding or altering in curature, five or six different radii; that is, a 4 in. radius will answer up to about 7 in. or 8 in. The plane can be obtained in two sizes, with seven wood sole plates and three irons ground to different radii. In addition to doing the work of an ordinary flat plane, it will make core boxes up to any size, and can be easily adapted to innumerable other shapes.

The saving effected in time in a shop employing five to twelve or fifteen men is so considerable as to merit the attention of all firms laying one on their benches. We are indebted to Mr. E. Haydock, of 15, Goldschmidt Street, Chorlton-on-Medlock, Manchester, the inventor of the plane, for the above particulars.

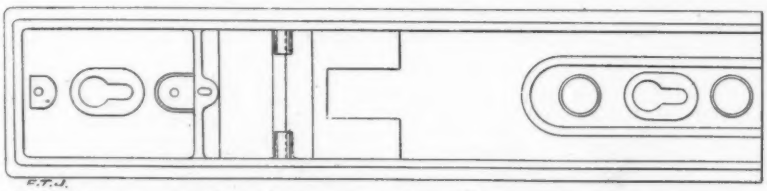


FIG. 3.—PLAN OF THE STOCK SOLE WITH THE PLANE IRON AND ADJUSTMENTS REMOVED.

FIG. 4.—ANGULAR TRANSVERSE SECTION ON SECOND LINE, FIG. 1.

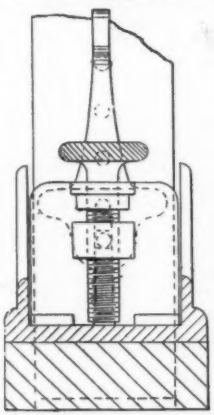
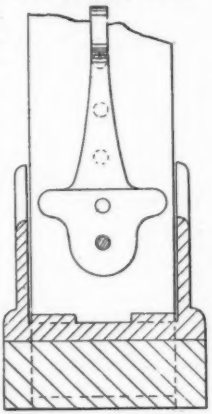


FIG. 5.—ANGULAR TRANSVERSE SECTION ON FIRST LINE, FIG. 1.



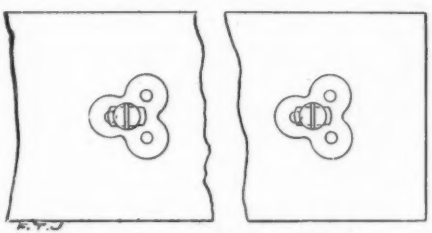


FIG. 6.—PLAN OF ADJUSTABLE SOLE.

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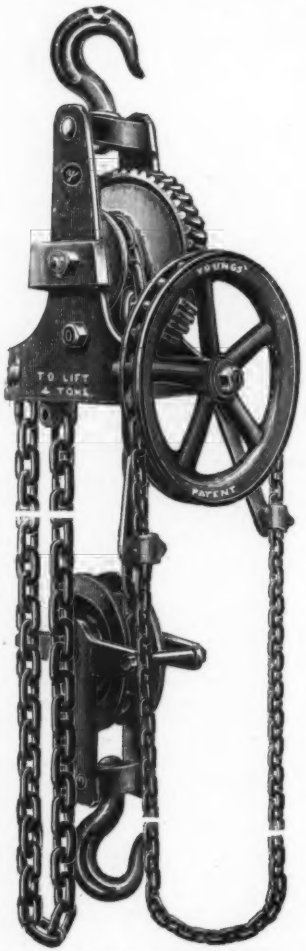
THE GRADING OF SOUTHERN PIG-IRON.—The Southern States of America produced during 1903 some 2,138,125 tons of foundry pig-iron, or practically half of the 4,409,023 tons produced in the entire United States. Southern iron is sold under the following grades, and while silicon is not guaranteed it usually runs about as follows:—No. 1 silvery, 4 to 5 per cent.; No. 2 silvery, 3 to 4 per cent.; No. 1 soft, 3 per cent.; No. 1 foundry, 2.75 per cent.; No. 2 soft, 2.50 to 2.75 per cent.; No. 2 foundry, 2.35 per cent.; No. 3 foundry, 1.90 per cent.; No. 4 foundry, 1.75 per cent., although it often runs much higher; gray forge, 1.35 per cent.; mottled, 1 per cent.; white, 0.50 per cent. The silvery, soft, and No. 4 foundry are distinctively Southern grades and are distinguished by the dense silvery appearance of the fracture. Some of the leading furnaces in the South, however, are also willing to sell strictly by analysis, guaranteeing as follows:—Silicon, over 3 per cent.; sulphur, not over 0.05 per cent. Silicon, 2.50 to 3 per cent.; sulphur, not over 0.05 per cent. Silicon, 2 to 2.50 per cent.; sulphur, not over 0.05 or 0.075 per cent. Silicon, 1.50 per cent. and under; sulphur, not over 0.075 per cent.

YOUNGS' WORM SCREW PULLEY BLOCK.

THE illustration shows a patent worm screw pulley block, manufactured by the well-known manufacturers of lifting. and hoisting machinery, Youngs', whose works



YOUNGS' WORM SCREW PULLEY BLOCK.

are in Ryland Street, Birmingham. The special feature of this worm screw pulley block is that it is automatically self-sustaining, without the aid of the usual ratchet and pawl and spring. The ratchet and pawl alone are unreliable, and this has caused some to attach a spring to the pawl to keep it in the ratchet wheel; but the spring also gets out of order, with the result that the load frequently runs away and causes great danger to those working the blocks.

Youngs' patent worm block brake consists of two cams turned on the worm spindle, which fits into two brass segments held in the front end of a brake box by a cap. In the back end of a brake box is a split cone ring, which fits on to a cone which is cast on the bracket. When lifting the load the brake box remains stationary, being held by the frictional contact of the split cone ring on the inside of the brake box, whilst the cams driving forward carry the brass segments freely round in the brake box.

Immediately hoisting ceases the backward pull of the load operates the cams and expands the segments, wedging them against the side of the brake box, which is held stationary by the frictional contact of the split cone ring on the brake box, and thus sustains the load. To lower the load the hand chain is pulled in the reverse direction, when the brake box is carried backward with the spindle, and the friction at the periphery of the split cone ring (which is just sufficient to sustain the full load) being easily overcome by the pull on the hand chain, the load descends. This arrangement renders the brake entirely automatic in its action, and correspondingly easy in its working, as the fractional brake-power is always in direct proportion to the weight which is being lifted, whilst the entire absence of springs, ratchets, and pawls removes all sense of insecurity and doubt, and renders the block more safe, and at the same time more easy and reliable in its working. The arrangement is working in several foundries.

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COKE SPECIFICATIONS.—"We all know," says Dr. Moldenke, "that too much sulphur is detrimental. We also know that it is not the appearance or the name of a coke that makes its good melting qualities. Even the tough looking by-product article is now recognised as first class, if it is of the proper composition, and the burden of the cupola be arranged to suit its structure. A committee is at the present time being formed in America to study the question of a standard foundry coke, issue specifications for the purchase of this standard with penalty and bonus for variations therefrom. So in a short time this issue will be dealt with and bring much good to the foundryman."

MELTING PLANT FOR BUENOS AYRES WESTERN RAILWAY.

THE annexed illustrations show a melting plant, recently supplied by Messrs. George Green & Company, of Crosshills, Keighley, for the Buenos Ayres Western Railway Company's new Liniers workshops. The installation comprises a pair of "Rapid Economic" cupolas, with charging platform and a 20 cwt. pneumatic hoist for raising the coke and iron to the charging platform. The contract further included two Root's patent blowers, direct coupled to Westinghouse electric motors with the necessary cast iron blast pipes.

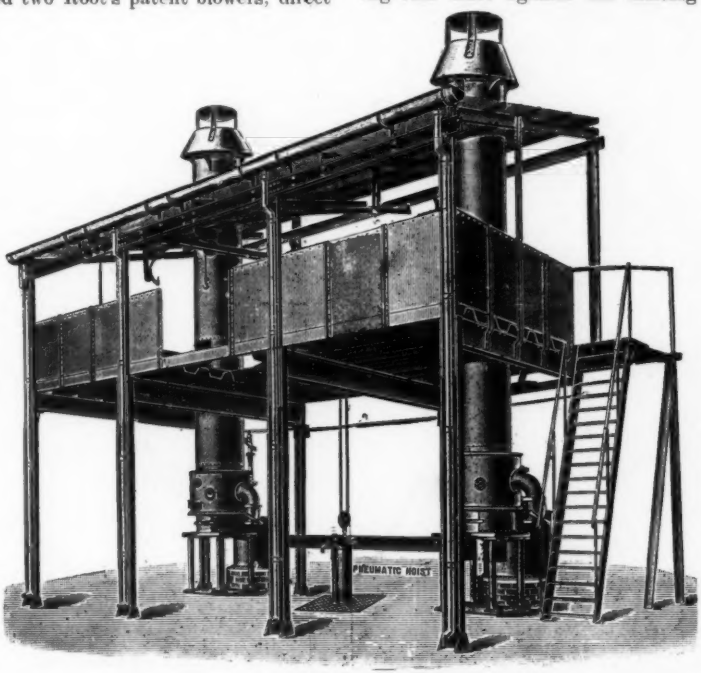

FIG. 1.—MELTING PLANT AT THE LINIERS SHOPS OF THE BUENOS AYRES WESTERN RAILWAY COMPANY. BUILT BY GEORGE GREEN & CO., KEIGHLEY.

The cupolas supplied are capable of melting four tons an hour. Their total height from the ground is 24 ft. 8 in., and the height to the charging hole is 18 ft. 6 in. The outside diameter of the shell is 3 ft. 6 in., and the inside diameter at the tuyeres 1 ft. 8 in.. The cubic feet capacity is 401, and the total weight, exclusive of bricks, is 4 tons 15 cwt. The fire brick lining weighs approximately 8 tons.

The most distinctive feature of this cupola lies in the tuyeres. These tuyeres, (see Fig. 2), are each capable of regulation by means of the sliding lid which is fitted, which is a distinct advantage, as the supply of blast to each row of tuyeres may be regulated at will to suit individual requirements, or when nearing the end of a blow the top and middle row may be entirely closed in rotation, and the blow completed by the bottom row alone, which avoids the deleterious effect, as in an ordinary furnace, of blowing cold blast against the melting iron, which is the cause of the metal not being sufficiently fluid towards the end of a blow.

The diffused blast arrangement obtained by these tuyeres secures an entirely even combustion throughout the melting zone, by means of the air entering practically around the whole circumference of the melting zone, which results in a very large saving of fuel, combined with extremely rapid melting, producing an exceedingly hot and fluid metal, soft and uniform in texture, most desirable

features in machine castings. This, of course, is invaluable for producing the lightest as well as the heaviest castings.

The principle of distributing a soft blast evenly, as in this cupola, tends to preserve the life of the lining, and does not chill the slag and bung up the tuyeres.

Tests of the cupolas sent to Buenos Ayres are not available, but it is instructive to quote some results obtained at the Otley works of the Bremmer Machine Company, Limited. This cupola was a smaller sized one, melting 3 tons per hour. The test was as follows:—

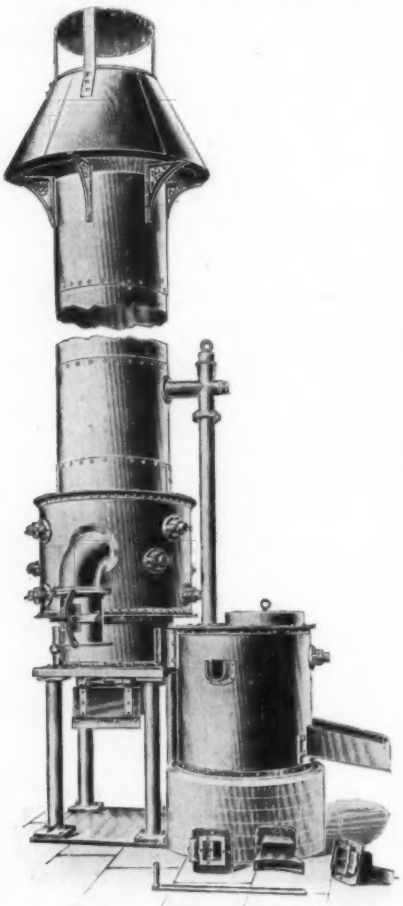

FIG. 2.

Cwts. of coke to 1 ton iron (inclusive of bed), 1.95 cwt.

Cwts. of coke to 1 ton iron (exclusive of bed), 1.41 cwt.

Total iron melted, 6 tons 21 cwt.

Time taken to melt, $2\frac{1}{4}$ hours.

Coke for fusion, $9\frac{1}{4}$ cwt.

Coke for bed, $3\frac{3}{4}$ cwt.

Total coke consumption, 13 cwt.

Metal running down in minutes after blasting, 11 minutes.

Size of blower, No. 2 Roots.

Revolutions per minute, 400.

Mean pressure of blast, $\frac{5}{8}$ lb.

Cubic feet of air per ton of iron melted, 41.221.

The Bremmer Company further state that French coke was used, and that the metal was extremely hot from start to finish. Allowing for about 2 cwt. of coke that had dropped through the bottom at the finish of the blow, these figures show a net consumption of fuel of about 8 per cent. of the iron melted.

Similar plants to the above have been supplied by Messrs. George Green & Company to various parts of the world. Another recent and very similar plant to the one in question has been supplied to the Patent Axle-Box and Foundry Company, Limited, Birmingham, a 20 cwt. hydraulic cupola hoist being substituted instead of the pneumatic hoist described above. A smaller plant consisting of two cupolas has quite recently been supplied to Messrs. Booth Bros., Dial Ironworks, Stourbridge, for making boot protectors and nails. The first half of this plant has now been working two or three months, and Messrs. Green & Company have received instructions to duplicate it as quickly as possible.

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STRAINAGE.—"J. W.," Glasgow, writes:—In a recent article I read "Allow $\frac{1}{2}$ per cent. for strainage." Please explain the meaning of the expression.

We understand the word strainage to mean, when used in connection with foundry practice, the tendency of the casting to become larger than the pattern, due to the liquid pressure at the time of casting. Castings are frequently thicker than the pattern. If the weight of the casting is computed by the dimensions on the drawing, and the pattern is made to the drawing, then $\frac{1}{2}$ per cent. of the computed weight should be added to the estimated weight so as to obtain the actual weight. In short, the above expression means the weight which must be added to the estimated weight to obtain the actual weight of the casting.

IMPACT TESTS ON METALS.*

By A. E. Seaton, of London, and A. Jude, of Birmingham.

Considerable movement has been made of late towards the establishment of a shock test for metal conducted on a smaller scale than is the custom with axles, for instance, where the full-sized article is tested. The authors are strongly of opinion that progress in this direction is taking place still too slowly. Although this question is of greater interest to the forgemaster than to the foundry man, the following remarks are applicable to all sorts of metals, and apply especially to brass or bronze castings, etc., as they are frequently required to stand shock. The shock tests made by the authors of this paper have been carried out in an apparatus, designed by the authors to require, as a rule, more than one blow to produce fracture. Such apparatus, as shown in Fig. 1, consists essentially of a weight of 6 lbs., arranged to drop freely through 24 in. on to the test-bar, Figs. 2 and 3, which rests on fixed supports 3 in. apart. The test-bar is 4 in. long, so that there is half an inch overlap at each end. After each blow the test piece is reversed. In the authors' opinion the apparatus to test the endurance of a material under shock should not be one in which the sample is fractured at the first blow, although they admit that for some purposes such a test may be instructive.

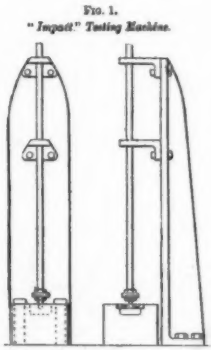
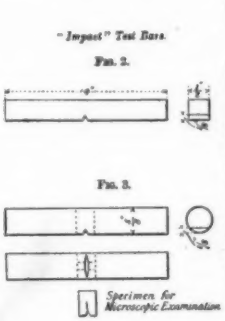


Fig. 1.
"Impact" Testing Machine.



At present everybody makes tension tests, and trusts more or less to them alone. One takes up an advertising or scientific article on, say, "Special Nickel Alloys," suitable for doing all sorts of wonderful things, and the first thing one is expected to be impressed with is the superior tensile and elongation results. One has occasionally yielded to the temptation to use such alloys for which a very big price has been paid, but they have usually proved no better servants than ordinary material. It is sometimes stated that an ordinary mild steel (say "Admiralty" grade) is not good for certain purposes, but that a particular "special" steel is perfectly safe, etc., because the elastic limit and tensile strength are somewhat better.

How much is this tensile strength and elastic limit thereby raised? The answer is—anything from about 5 to 30 per cent.

This increased percentage must be a mere trifle for such articles as are subjected to stresses or shocks of an unknown effective magnitude. But, nevertheless, it is certain that such treated steel is suitable for its purpose, and it is evident, therefore, that something far more important has been contributed to the original qualities of the material than the mere improvement in tensile properties to account for it. To anticipate a little, it is because the shock strength is improved several hundred per cent. as against the insignificant increase of, say, 30 per cent. at most in the tensile strength and elastic limit.

The following are the tests that can be made on most pieces of metal, steel in particular :—(1) Tension and elongation. (2) Compression. (3) Cross-bending. (4) Hammering out to a point or thin edge. (5) Fatigue by gradual reversal of stress either by bending in one plane or by rotation. (6) The same, but with the stress uniformly distributed over the section, as suggested by Professor Osborne Reynolds. (7) Impact on unnotched bars. (8) Impact on notched bars. (9) Chemical analysis. (10) Micro-analysis. There may be variations of the above. The general uses of steel may be divided into three main groups :—(*a*) Work subject to steady loads only, such as buildings, tanks, etc. (*b*) Work subject to recurrent loads at intervals, such as bridges, etc. (*c*) Structures subject to rapidly repeated loads of one kind, all more or less suddenly applied, as with bolts and

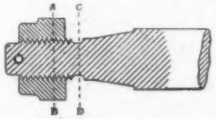


Fig. 4.—Fracture of Piston-rods.

* Abstract of paper read before the Institution of Mechanical Engineers.

studs, rails, etc. (*d*) Structures subject to alternating loads, such as in the fixed and moving parts of machinery in general.

For the first two there is no doubt that the tension test is a good and sufficient one, as the predominant stress is certainly pure static tension, but it will be insufficient for the very heterogeneous groups (*c* and *d*). The question may then be asked, which of the tests in the above long list is really a true universal gauge of the suitability of a piece of steel for any purpose it may be put to? As a help to answer this question, attention may be drawn to the following analysis of stresses in the steel parts of an up-to-date steam-engine of moderate size :—

	Per cent.
Constant tension	3.91
Constant tension and compression (range $\frac{0}{\text{max}}$)	1.30
Constant tension and shock	48.80
Alternating tension and compression with shock	2.81
Repeated tension (from a constant to max.) with shock	36.00
Miscellaneous and doubtful	7.17
Total	100.00

It will be seen that 87.6 per cent. of the whole engine is subject to more or less shock, while pure tension forms an insignificant percentage of the total stress.

Referring again to the steam-engine, there are important parts, such as the piston-rods and connecting-rods, that, under ideal conditions of working, are subject mainly to direct alternating stresses. When, in the majority of cases, a piston-rod gives way, it breaks at the end through the line A B, Fig. 4, and not through the smallest area C D, supposing that happens to be less than the area at the bottom of the thread. In fact, it is dislocated through a section where the effect of repeated blows can accumulate. There is undoubtedly, in addition to the suddenly applied steam loads, a series of true though comparatively minute blows (with proper adjustment) arising from the necessary slackness in all the bearings.

The authors also instance a case in which some studs were broken in which the working stress probably never exceeded $2\frac{3}{4}$ tons, and certainly could not have exceeded $4\frac{3}{4}$ tons per square inch. In no case did the rate of variation of the stress exceed 350 per minute. With a range of stress anything below about $11\frac{1}{2}$ tons per square inch, and with 1,880 reversals per minute, it should be impossible to break such a steel bar. The total number of variations in six particular cases of the broken studs ranged from 3,240,000 to 15,400,000, which represents, after all, only a short life of a few days in the case of some modern engines. It seems as if the reason can only be shock, that is, a number of minute blows more or less persistently applied.

Reverting to the question, "Is there for groups (*c* and *d*) in particular one comprehensive test?" The following appears to be the practical answer :—

"Simple Tension" is not.

"Bending" is not sufficient.

"Impact" on plain bars is doubtful—certainly too tedious if without distortion.

"Reversal of stress" by either method (before described) is fairly good, but

"Impact on a notched-bar" is best of all.

First, because it appears to be a gauge of the preponderant stress. Secondly,

ACTUAL LINE OF FRACTURE BY SHOCK.

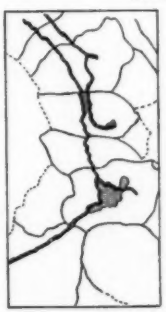


FIG. 5.—MILD CAST STEEL (PEABLITIC) HEAT-TREATED.

FIG. 6.—FORGED MILD ADMIRALTY STEEL (PEARLITIC 2.5 C.)

because experience shows that with absolute certainty there is always good enough ductility when there is a good resistance to shock.

It must not be concluded that the factors of elastic limit, etc., are despised, but since the forces that cause breakage are in practice far below the elastic limit in magnitude, and, moreover, as the factor of safety is quite arbitrary and the same in no two pieces of machinery, it seems to the authors that the cart is put before the horse to a great exent.

Opinions differ as to the best means of making the impact test, but, on the whole, the consensus of opinion appears to be that it should be made with a machine that breaks at one blow, and at the same time measures the energy ex-

pended in breaking the specimen. M. Frémont thinks that breaking by a series of blows gives results that are similar to those from a static bending test, that is, they are more a gauge of ductility and tensile strength than of resistance to shock. The authors are not with him in this opinion, provided that the blows are not heavy enough to produce material bending.

From the very many bars that have been tested by them they have found the number of blows to produce fracture is a fair gauge of the toughness or anti-brittleness. But there is no relation whatever between this result and the tensile results except what has previously been mentioned, namely, that if the impact result is good the elongation is sure to be good too, but, on the other hand, metal showing high tensile strength and good elongation may be useless to resist shock.

It has been said previously that the maximum shock strength for the particular grade of steel containing 0.25 per cent of carbon is about thirty blows as gauged by the authors' machine. Although thirty may be a fair figure, such steel cannot be relied upon to give this always. With the usual factors of safety considered by authorities to be sufficient, they find that for those parts subjected to more or less shock, there is a grave risk of them breaking under the modern conditions of high speeds. The authors have no hesitation in venturing the opinion that the comparative immunity from failure that does exist in machinery is due to the liberal data on which the designer usually bases his calculations and to the "extra allowance for practical purposes" that creeps in all designs, thus bringing up the real factors of safety to a figure considerably higher than that primarily intended to be used.

The majority of steel users require that they shall be able to use an ordinary steel as supplied to them, and without annealing, tempering, or other heat treatment. The authors, therefore, urge that the engineer should demand of the steel maker a greater attention on his part to produce and supply the ordinary grades of steel with a more uniform "shock" quality.

Microscopic Researches.

Dealing with the results of their microscopic researches, the authors state that since in a "saturated" steel the line of fracture is necessarily through pearlite, an exceedingly brittle substance compared with ferrite, the natural conclusion is that the line of fracture will be in all cases through as much pearlite as it possibly can. There also appears to be yet a prevalent idea that fracture of any kind takes place more or less along the crystalline grain junctions.

In the series of photographs, Figs. 5 to 8, the dark areas are pearlite and the white areas ferrite. The dark line runing through the field is the actual line of fracture under shock. These photographs lead to the following conclusions:—

First, that in any grade of steel of the range under consideration, the line of fracture does not go through as much pearlite as possible; further, that it distinctly avoids doing so, but really goes through as much ferrite as possible.

Secondly, that fracture through the ferrite crystalline junctions is extremely rare, and really is practically always through cleavage planes.

The authors have also observed that the

ACTUAL LINE OF FRACTURE BY SHOCK.

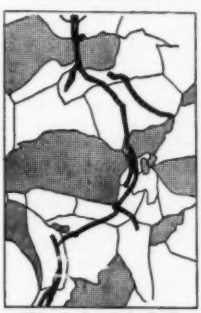


FIG. 7.—MILD CAST STEEL (PEARLITIC) NORMAL.

FIG. 8.—MILD CAST STEEL (PEARLITIC) NORMAL.

fracture appears to follow an erratic course both in saturated and under-saturated steels; in the latter the controlling agent is evidently the ferrite, but in the former the reason is obscure.

It will thus be seen that by the first statement above, there is a contradiction to the second natural conclusion arrived at (above), that fracture would of necessity take place through a maximum of pearlite.

There is also an apparent contradiction to the first natural conclusion that increased brittleness is the outcome of an increase in the quantity of pearlite. To this latter it is obvious, of course, that there is no real contradiction, seeing that carbon is the only variant.

The authors have plenty of articles broken by what they believe to be shock,

and there appears to be a perfect identity between the microscopic appearance of the fracture of these articles and their test-bars broken by shock.

The results are summarised as follows:—

(1) Impact test-bar fracture is through ferrite, and has no slip-bands.

(2) Fractured bolts, etc., show no drawing out or slip-bands.

(3) Alternating stress (rotating) test-bar fracture is through ferrite, with external slip-bands in profusion, and internal slip-bands sometimes visible; but there is no drawing out of crystals.

(4) Tension test-bar fracture is accompanied by slip-bands in profusion, and with the crystals very drawn out.

(5) Fracture by direct intermittent stress is highly improbable.

In the foregoing, the subject matter has been strictly confined to the strength, etc., of steel in its natural condition, or that condition produced by the comparatively slow cooling process of ordinary manufacture. The shock strength of "treated" steels, however, is a matter of equal, if not greater, importance. The authors have not had the time nor facilities for conducting a complete series of experiments with these steels, but they have done quite sufficient to be assured of the fact that the shock strength of oil-quenched mild steels particularly is not increased a mere matter of 20 per cent., as in the case with the tensile strength, but on an average 500 to 600 per cent. more than the shock strength of the natural steel in its best condition.

—o—

THE COMPOSITION OF ALLOYS.

Ordinary brass, consisting of two parts of copper and one part of zinc, is too soft for general use; its resisting power is small, and it is suitable only for ornamental purposes.

An alloy having three parts of copper and two parts of zinc may be rolled into bars and plates. By adding about 1 per cent. of tin an alloy capable of resisting sea water is obtained. So it enters largely into maritime construction, being used, among other purposes, for all the machine accessories of warships exposed to sea water.

While the ordinary condensing tubes have a composition of 70 per cent. of copper and 30 per cent. of zinc, the British Admiralty requires a metal having 70 per cent. of copper, 29 per cent. of Silesian zinc, and 1 per cent. of tin. The boiler tubes are composed, on the contrary, of 68 per cent. of copper and 32 per cent. of zinc.

There are a great variety of bronzes. That required by the British Admiralty for propelling screws and for all castings for warships contains 87 per cent. of copper, 8 per cent. of tin, and 5 per cent. of zinc. The metal having 90 per cent. of copper and 10 per cent. of tin is stronger, but is not suitable for this use. The addition of a certain proportion of zinc is necessary. A harder alloy contains 84 per cent. of copper and 16 per cent. of tin.

In many cases durability is of more importance than tensile resistance; for example, for bearings. In this case an alloy of 79 per cent. of copper and 21 per cent. of tin is employed. By adding a slight proportion of phosphorus the metal also becomes very hard. But this has the inconvenience of becoming brittle by heat. Much care is necessary in melting it, and repeated fusion diminishes its quality. Cold, it can be drawn out into wire. It enters into the preparation of the blades of screws, bearings, pump rods, etc.

Bronzes are much improved by the introduction of ferro-manganese, which has the effect of rendering the metal denser and more homogeneous by deoxidising the oxides of copper mechanically interposed.

Of white metals there are a great variety, each maker extolling his own formula. Among those the most in use are the Parsons, the Babbits, the Fenton, the Stone, and the Basilens alloys. A short time ago the Babbits white metal was the most employed, in particular for bearings. The most approved formula had 10 parts of tin, one part of copper, and one part of antimony. A very good alloy is obtained by forming a mixture of six parts of tin with one part of copper, and another of six parts of tin and one part of antimony, and then uniting the two mixtures.

The Parsons metal is composed of 68 parts of tin, 30.5 parts of zinc, one part of copper, 0.5 parts of lead. It is used for fittings and bearings, but is not very suitable for the last-mentioned use.

The foregoing is a translation from "Revue de Chimie Industrielle.

—o—

Mr. John McLaren, of J. & H. McLaren, Midland Engine Works, Leeds, and Mr. George Craddock, of Geo. Craddock & Company, of Wakefield, recently gave evidence before Mr. Chamberlain's Tariff Commission.

TRADE TALK.

THE LINCOLNSHIRE PIG-IRON ASSOCIATION has advanced the prices of pig-iron.

THE CARNFORTH HEMATITE IRON COMPANY, LIMITED, have recently put another furnace into blast.

CHADWICK ENGINEERING COMPANY, LIMITED, has been registered with a capital of £2,000.

THE WREKIN FOUNDRY, LIMITED, Wellington, Salop, is to be offered for sale by public auction shortly.

MILLS, ENGLISH & COMPANY has been turned into a limited company with a capital of £30,000.

THE LEA FOUNDRY, Darwen, Lancashire, belonging to Messrs. J. and R. Shorrock, has been offered for sale.

THE REUBEN CHAMBERS ENGINEERING WORKS, Dartmouth Street, Birmingham, were the scene of a sale last month.

MESSRS. A. SPAFFORD & COMPANY'S IMPERIAL TOOL WORKS, Brown Street, Sheffield, was recently damaged by fire.

COWAN'S LIMITED, have changed their London address from 82, Victoria Street, S.W., to 4, Queen Victoria Street, E.C.

MR. RICHARD LEWIS' foundry at Aberdare, South Wales, was recently the scene of a fire, doing damage, it is reported, to the amount of £4,000.

MESSRS. O. BENDALL and L. H. BENDALL, ironfounders, Lawford, Essex, trading under the style of O. Bendall & Son, have dissolved partnership.

THE CLYDE STEEL WORKS, Sheffield, of Messrs. Samuel Osborn & Company, was recently the scene of a fire. The damage was not very serious.

MR. J. CHILD, of 108, Claremont Road, Liverpool, W., has been appointed sole British representative for Messrs. Eugen Blasberg & Company, of Düsseldorf.

MESSRS. MACKAY BROTHERS, who have now completed the fitting out of their new shipbuilding yard at Alloa, are about to start work on their first contract.

MESSRS. EAST & NEPHEW'S WORKS, at Greet's Green, West Bromwich, which were known as the Staffordshire Foundry, are, it is rumoured, shortly to be restarted.

LOUDON BROTHERS, LIMITED, has been formed with a capital of £40,000, to acquire the business of engineers, carried on by Loudon Brothers, at 39, West Campbell Street, Glasgow.

J. W. JACKMAN & COMPANY, LIMITED, engineers, with whom are the British Buffalo Forge Company, have removed their offices from Market Street to 1, Princess Street, Manchester.

MESSRS. H. BALDWIN and J. THOMAS, brass and iron founders, Burnham, Bucks, have dissolved partnership. They traded under the style of Baldwin, Thomas & Company.

MESSRS. F. H. URRY and W. HAYDON, mechanical engineers, Church Street, Islington, London, N., trading under the style of W. Haydon & Company, have dissolved partnership.

MESSRS. W. J. PERRY AND H. A. AYLETT, electrical and mechanical engineers, Fulham Road, and Pelham Street, Chelsea, S.W., trading under the style of Perry & Aylett, have dissolved partnership.

THE PARK GATE IRON AND STEEL COMPANY, LIMITED, Rotherham, will shortly start their new blast furnaces. These new furnaces are of considerably increased capacity as compared with the old ones.

MR. J. WADDINGTON has severed his connection with Messrs. E. Waddington and J. B. Waddington, engineers and ironfounders, Barrow-in-Furness, who traded under the style of Joseph Waddington & Sons.

THE next general meeting of the Verein Deutscher Eisenhüttenleute is to be held in Düsseldorf on December 4, when Prof. Meyer will read a paper on "Large Gas Engines," and Prof. Dr. F. Wüst on "The Classification of Foundry Pig-iron."

THE thirty-third annual dinner of the Newcastle and District Association of Foremen Engineers and Mechanical Draughtsmen was held recently. Lord Armstrong presided, and Mr. W. A. Woodeson, President of the Association, was in the vice-chair.

MOUNTFORD, PHILLIPS, & COMPANY, LIMITED, of the Thorns Chain and Engineering Works, Brierley Hill, Staffordshire, who are the owners of the Cambrian Chain and Engineering Works, Llantrisant, contemplate transferring their Brierley Hill Works to Llantrisant.

GENERAL ENGINE AND BOILER COMPANY, LIMITED, has been formed with a capital of £25,000, to acquire the business of W. H. Northcott and E. Frampton, carried on as the General Engine and Boiler Company, at Hatcham Iron Works, New Cross, S.E.

Mr. Gilbert Little has lately founded a new works in close proximity to Mond's new Gas-Producer Works, near Birmingham. In the new works a considerable saving is expected to be effected in power by using Mond gas. Messrs. Little & Sons' works will be employed in the manufacture of elevating and conveying specialities.

The British Westinghouse Electric and Manufacturing Company, Limited, give the following particulars covering orders received during the past three years :—Orders received during the year ended July 31, 1902, £932,000; during the year ended July 31, 1903, £1,657,114; during the year ended July 31, 1904, £927,336. The company has taken orders during the first three months of the current year aggregating £311,000.

The American Car and Foundry Company have, it is reported, acquired a site in Trafford Park, Manchester, for the purpose of erecting large works for the manufacture of railway wagons and carriages. This company, it will be remembered, has just undertaken a contract for the supply of the railway carriages for the Baker Street and Waterloo Underground Railway in London. All these carriages will be built and finished at the new establishment in Trafford Park. The company expect to have the workshops erected and the necessary equipment installed and to commence delivering the finished carriages early in March.

Graham, Morton, & Company, Limited, of Leeds, have made the following offer to the Armstrong College of Science, Newcastle-on-Tyne :—Recognising, as we do, the importance of the movement, which has for its aim the combination of practical and theoretical training for our young men attending British universities, we are pleased to offer to such as have obtained the B.Sc. in engineering, a two or three years' course in practical work in our drawing office. We are also prepared to pay a small remuneration, commencing at 15s. per week first year, 20s. per week second year, and £2 per week third year, to applicants appointed to the vacancies that may from time to time occur here.

Messrs. W. Sisson & Company, who have been in business in Gloucester since 1889, have formed a limited liability company under the stye of W. Sisson & Company, Limited, and are now commencing the erection of new works of considerably increased size. The works are to be erected close to the main line from Gloucester to Birmingham, on a piece of ground about 4½ acres in extent. The works will cover about half an acre, and they comprise two bays of 174 ft. and one bay 162 ft. in length. The two longer bays provide accommodation for the boiler shop, machine, fitting, and erecting shops, and the third bay has two floors, the lower being for stores, tool room, and the general office, and the upper for pattern-making shop and drawing offices, etc.

COMPANY NEWS.

North Lonsdale Iron and Steel Company.—Dividend of 5 per cent.

Bell Brothers.—Interim dividend at the rate of 5 per cent. per annum.

Monks Hall & Company.—Interim dividend of 5 per cent. for the half-year ended October 31.

Alldays & Onions.—Net profit of £8,178. Dividend on the ordinary shares of 5 per cent.

Thos. Allan & Sons.—Dividend of 5 per cent. to be paid on preference shares, and 2½ per cent. on ordinary shares.

Midland Iron Company.—Profit is £4,041 5s. 8d. Dividend on ordinary shares 5 per cent. for the year.

Richard Hornsby & Sons.—Net profit of £18,265. Dividend at 6s. per share, free of income-tax, on ordinary shares.

John & Edwin Wright.—Profits for the year, £5,349. Dividend on the ordinary shares at the rate of 8 per cent. per annum.

British Westinghouse Electric and Manufacturing Company.—To July 31 last profits £50,550. After providing for debenture and loan interest, a balance of £2,809 remains.

Shotts Iron Company.—Net sum at credit of profit and loss account at September 30 last (including the balance brought forward from 1903), after deducting of depreciation, and setting aside £1,500 as a reserve for extraordinary repairs and payment of an interim half-yearly dividend, profit is £10,485. Preference shares 4½ per cent.; ordinary shares 3s. per share.

OBITUARY.

Mr. H. Brownsword, of Heaton Moor, formerly an ironfounder at Heaton Norris.

Mr. Herbert Le Neve Foster, of Temple Row, Birmingham. The deceased was formerly connected with the Shelton Company.

ELDERS FOUNDRY COKE

As supplied to the

British . .

Admiralty Dockyards.

The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.

From THOMAS LAKE & SONS, Barnstaple.
Barnstaple, October 5th, 1904.

Please send us a truck of your BEST QUALITY FOUNDRY COKE as before The last lot was of first-rate quality. Please let us have the same kind, and much oblige.

From J. T. M. WILSON, Esq., Southampton.
Southampton, October 24th, 1904

Kindly forward a..other truck of Coke, about the same as last. I am very pleased with it

From PECKETT & SONS. Bristol.
Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time.
We have pleasure in stating thar we are very pleased with it, as we find we get sounder and cleaner castings, more free from blow-holes and other defects, than we formerly did.

From MOUNTFORT PHILLIPS & Co., Llantrissant.
Llantrissant, October 25th, 1904.

In reference to the Foundry Coke you have been supplying us with for the last six months, we have very great pleasure in letting you know that it has given every satisfaction, and that our Works Manager and Workmen give it the highest praise.

From THORNEWILL & WAREHAM, Ltd., Burton-on-Trent,
Burton-on-Trent, October 25th, 1904

We have pleasure in stating that the Foundry Coke you have supplied to us is equal, if not superior, to any we have obtained elsewhere, and has given us perfect satisfaction.

From SAXBY & FARMER, Ltd., Chippenham (Wilts).
Chippenham, October 26th, 1904.

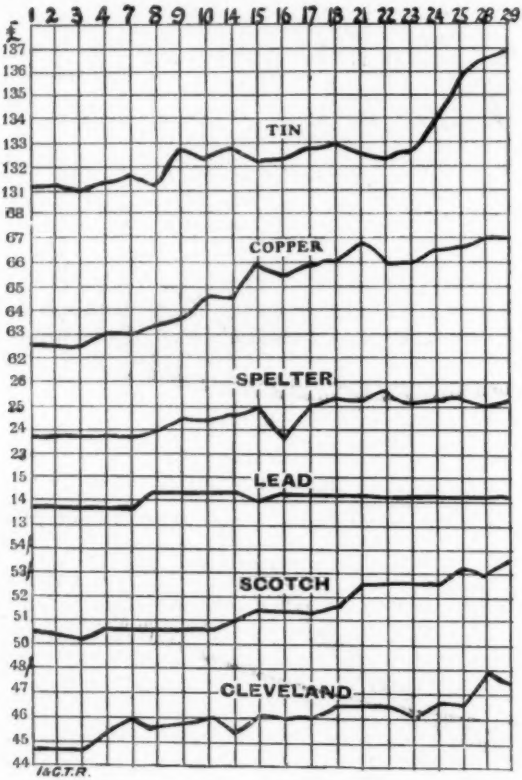
We are in receipt of your favour of the 24th inst. addressed to our London House, and in reply beg to say that we have been using your Coke for some considerable time past, and have always found it to be a first-class Foundry Coke, turning out good soft castings.
The melting properties we consider good, as the following will show; Average weight of Coke per ton of Iron melted being 2½ cwts.

From JOHN SHEARMAN & Co., Ltd., Cardiff.
Cardiff, October 27th, 1904.

We beg to acknowledge receipt of your letter of the 24th inst., and in reply have pleasure in stating that we have found your Coke to be of excellent quality, and far superior to any other we have used.
We have no hesitation in recommending it to anyone for Foundry and general use,

Elders Navigation Collieries, LTD. Cardiff.

CHART OF THE FLUCTUATIONS OF THE METAL MARKET IN NOVEMBER.



PRICES OF METALS.

Metals.	1901.	1903.
Iron—Scotch pig warrant ... ton	53 6	48/9
—Middlesbro' warrants ... ... ton	48 5	41/6
—W.C. M/nos Bessemer ... ... ton	56/0	55/0
—Stock. Scotch, Dec. 12. ...tons	10,322	9,479
Copper—Chili bars, GMB ... ... ton	£65 2/6—£65 7/6	£56 15 - £56 16
—Stock, Europe & afloat... ... tons	16,044	12 743
Tin—English ingots ton	£132—£132 10	£127—£127 10
—Straits ... ton	£131 5-£131 10	£123 15-123 17/6
—Stock, Ldn. Hlnd and aflt ... tons	11,261	12,623
Lead—English pig ton	£13 - £13 2/6	£11 5—£11 7/6
Spelter—Ord. Silesian ... ... ton	£24 15—£25	£20 17/6—£21
Quicksilver-(75lb.) bottle	£7 15	£8 5
Antimony—Regulus ... ... ton	£29—£30	£25—£25 10

In the Cleveland district the following are the nominal rates current for castings :—

Iron Castings.

	£ s. d.		£ s. d.
Columns (plain)	6 10 0	to	7 0 0
,, 3 to 4 in....	4 10 0	to	4 17 6
,, 10 to 16 in....	4 7 6	to	4 10 0
,, 18 to 24 in....	4 7 6	to	4 10 0
Chairs	3 7 6	to	3 10 0

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Does **more and better work in one hour** than can be done by **two men in ten hours** in the ordinary way.

ADVANTAGES.

1.—Requires very small driving power.—One H.P. for 2 tons per hour.
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3.—Durable. Repairs are hardly ever necessary.
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Ironfounders or their Managers invited to see the Machine at Work.

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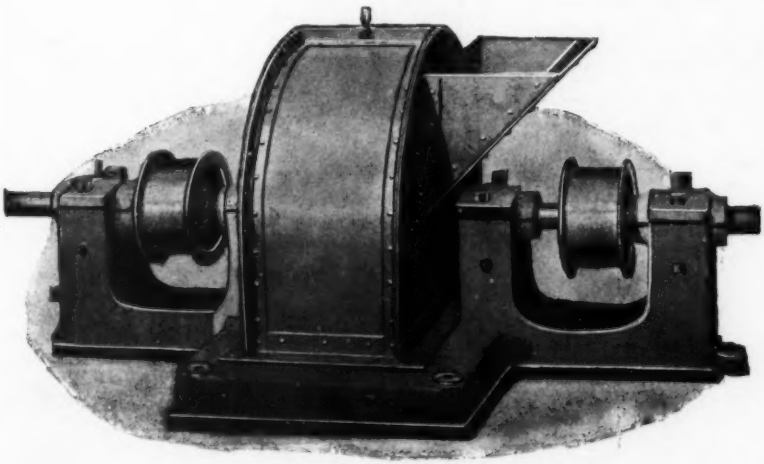

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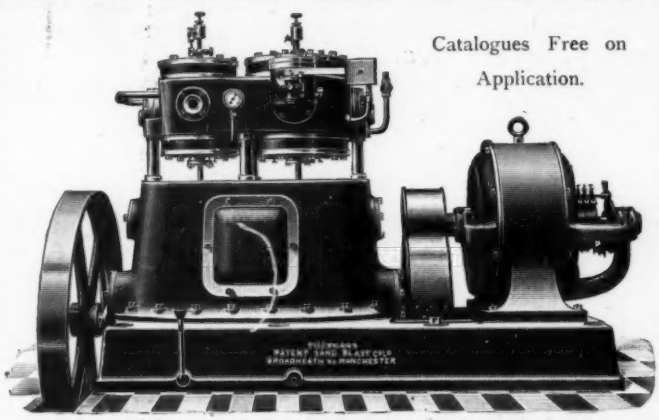

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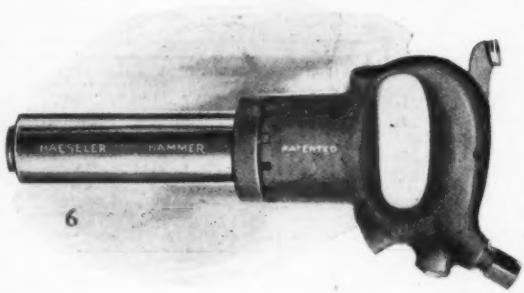

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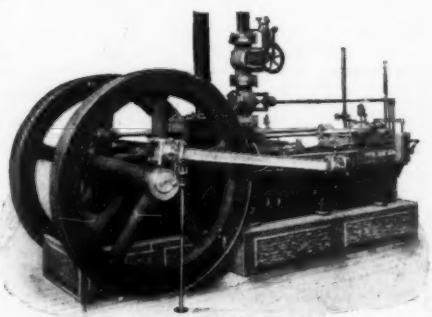

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Mr Bowman

The Foundry Trade Journal, AND THE IRON AND STEEL RECORD.

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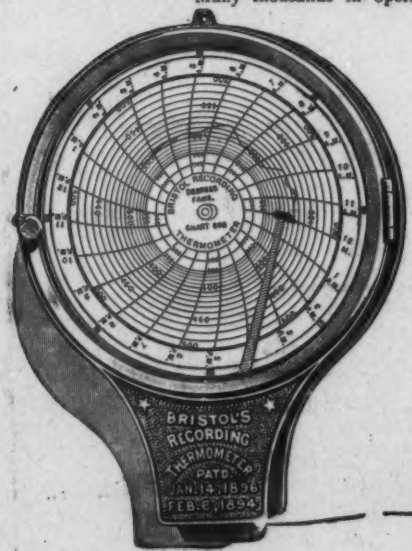

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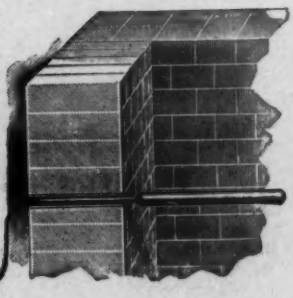

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